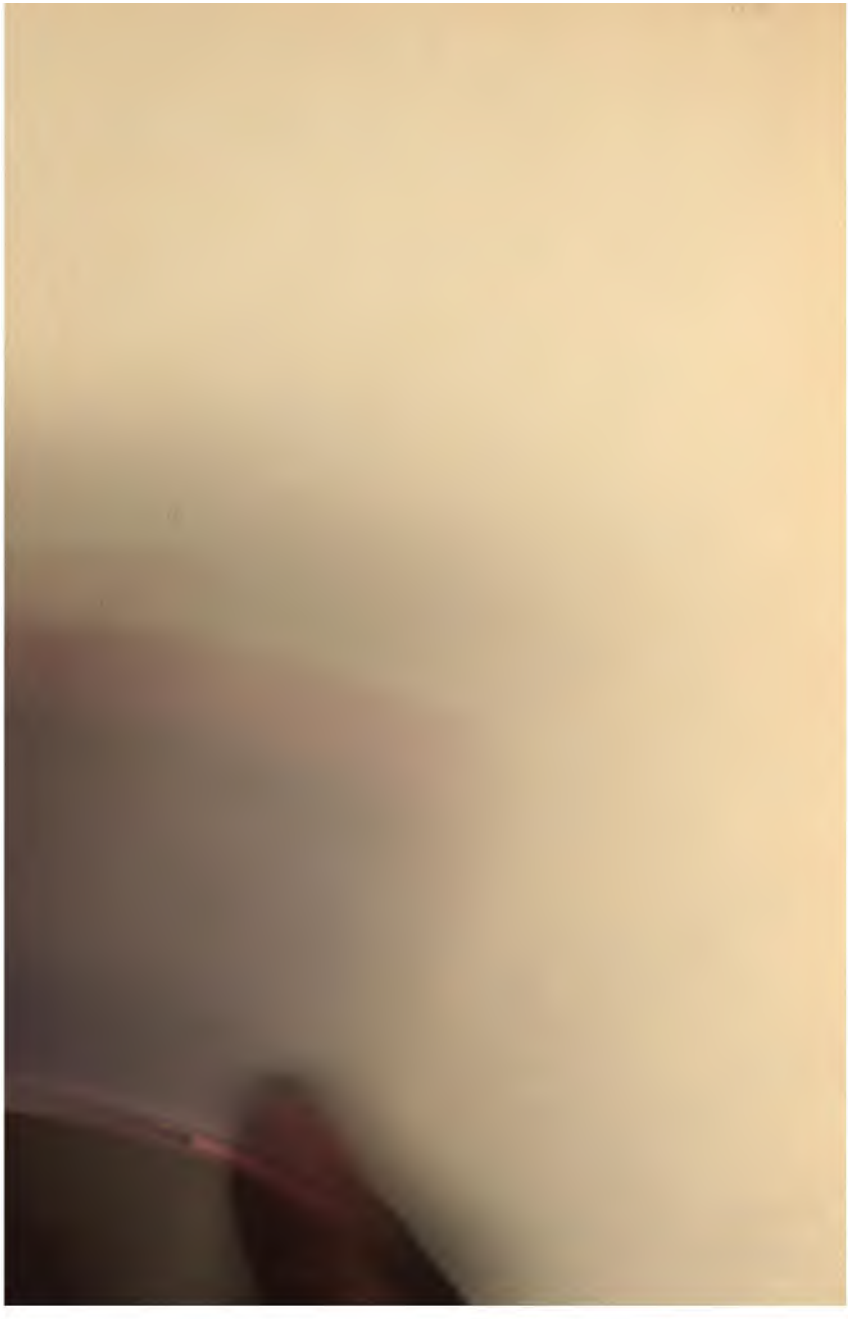

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PREFACE
TO THE
SECOND EDITION.

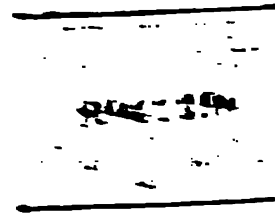
The first edition having been exhausted the author has thoroughly revised the work, and now presents it with some additions which he believes will add to its value.

ILLINOIS COLLEGE OF PHARMACY,
Chicago, February, 1887

PREFACE TO THE FIRST EDITION.

A fair knowledge of weights and measures and their applications is a necessary part of the preparatory studies of every physician, pharmacist and chemist. At this time, especially, is it important that students of medicine and pharmacy should be thoroughly familiar with the several systems of weights and measures in use, and with the manner of using them, since more than one system is now actually employed, and the Pharmacopœia not only uses the weight units of two different systems, but in general, leaves the choice of weights to the operator.

An adequate treatise on metrology has, therefore, become a necessity, and the Author offers this manual as perhaps sufficient both for the purposes of a textbook for students, and



the same temperatures as unit, have been prepared for this work, at the author's request, by Dr. A. B. Lyons, of Detroit, to whom thanks are due for these, as well as for the table of specific volumes on pages 156 to 159.

The applications of weights and measures to prescribing and dispensing, and to the construction of formulæ for liquid preparations, have received merited careful attention.

Those who desire to pursue these studies further will find much valuable and interesting information in the reports of Thomas Jefferson (Works of Thomas Jefferson, Vol. VII., pp. 472 to 495), and of John Quincy Adams (City of Washington, 1821); Barnard's *The Metric System;* the report of Alfred B. Taylor, published in the proceedings of the American Pharmaceutical Association, 1859; and the report of the committee on Coinage Weights and Measures of January 7, 1879 (45th Congress, 3d Session, H. R. Report No. 53).

Chicago, October, 1885. O. O.

TABLE OF CONTENTS.

METROLOGY.

Introductory.

1. **Metrology.**—The study of measures of extension, volume and weight, and of the relations of these to each other, is called *metrology* (from the Greek words μέτρον, measure, and λογος, discourse.

2. **Measures of Extension** are of two kinds: 1. Linear measure; 2. Surface measure.

3. **Linear Measure** is the measure of distance or length, as a mile, an inch, five meters, a fathom, etc.

4. **Surface Measure** is the measure of surface or area, as square miles, square meters, acres, square inches, etc.

5. **Measures of Capacity and of Bulk** are expressed either in cubic measures or in standard units of dry or liquid measures.

6. **Cubic Measures** express capacity in cubes upon the measures of linear extension, as in cubes upon the inch, foot or meter.

7. **Dry Measures and Liquid Measures** are arbitrarily chosen standards of comparison, as a bushel, quart, liter, etc. There should be but one kind of measures of capacity, the same measures to be used for both dry substances and liquids. Dry substances should generally be weighed, not measured.

8. **Mass Attraction.**—All bodies in nature are mutually attracted to and by each other, the force of this attraction

being in direct ratio to their masses, or the amount of matter they contain, and in inverse proportion to the squares of their distances. This form of mass attraction is called the *law of gravitation.*

9. **The Earth's Attractive Force.**—The mass of the globe being greater than that of any other body in our atmosphere, we ordinarily take notice only of that attractive force which the earth exerts upon all bodies upon or near its surface.

10. **Weight** is the ruling power by which the earth attracts towards its center other bodies of lesser mass. Thus it is the pressure which a body exerts upon a horizontal plane that supports it.

11. **Gravity.**—A body whose gravitation is exactly equal in all directions remains suspended in space. "Such a body, in relation to other bodies, has *gravity* but not weight."

12. **Specific Weight** is the relation of the weight of a body to its bulk.

13. **Specific Volume** is the relation of the volume of a body to its weight.

Standards.

14. **Standards of Comparison.**—All values of whatever kind are relative only. Hence measurements of values refer to *standards of comparison,* which are known values of perfect sameness.

15. **Primary Standards.**—Upon analysis we find that all measures of value have a direct or indirect relation to extension.

The units used to express value—whether of money, ts or measures, or of specific gravity or specific volume—founded primarily upon the measure of length.

erfect system of metrology and money should, there-

fore, bear a simple relation to some constant and indestructible object, the length of which is known or can be readily determined with sufficient accuracy.

Among the unalterable geographical magnitudes which have been considered in connection with metrology are : *the length of the seconds pendulum;* and *the meridian, the equator, and the polar semi-axis of the earth.*

16. Knowing their exact relations to the lengths of the seconds pendulum, the meridian, etc., we could replace all the meter sticks, yard sticks, gallon measures, pound weights and other standards used for the measurement of values, without deviation or error, should they ever be lost; for the lengths of the seconds pendulum, the meridian, etc., can be ascertained again, and new standard yard sticks, etc., thereupon constructed.

17. The natural dependence of all other kinds of measures upon the measures of length is best illustrated by the decimal system of weights, measures, and money of France. In that system the *meter* is the standard unit of linear measure. This meter is the ten-millionth part of the length of the fourth part of the meridian of the earth, which is the basis of the whole system; the cube upon the one-tenth part of the meter is the standard unit of fluid measure—the *liter*; the *gram*, which is the standard weight unit, is the weight of one cubic centimeter (the cube upon the one-hundredth part of the meter) of pure water; and the monetary unit, the *franc*, is represented by five grams of coin silver.

The English and American *inch* is now based upon the length of a pendulum vibrating seconds, in vacuum, at the latitude of London, and at the level of the sea. The length of such a "seconds pendulum" is 39·1393 *inches*. The weight of one *cubic inch* of pure water (at 62° Fahrenheit, under the pressure of one atmosphere) is declared to be 252·458 *grains*. The *avoirdupois pound* is equal to 7,000 such grains;

and the volume of ten such pounds of pure water (at 62° Fahrenheit) is the *Imperial gallon.* The *wine gallon* is 231 cubic inches; and the *troy pound* is equal to 5760 grains.

Systematic Metrology.

18. There are four principal conditions requisite to the construction of a perfect system of metrology. These are:

1. It must be in accord with our arithmetic, that is, it must be decimal.

2. It must rest primarily upon a physical constant.

3. All of its units of measurement, whether of length, surface, volume or weight, must bear the simplest possible relation to each other and to the primary unit of linear measure.

4. The units of weight and of volume must bear the simplest possible relation to the substance chosen as the standard of comparison for the expression of specific weight (water).

Any system of weights and measures which fails to fulfil these conditions, or any of them, is to that extent defective.

Prototypes.

19. **Actual Standard Measures and Standard Weights.**—Accurate models or prototypes have been made of the principal units of linear measures, measures of capacity, and weights. These actual standards are usually legalized, are carefully preserved in the custody of governments, and serve as originals, of which copies are taken directly or indirectly for ctual use.

The distance from one point to another, when expressed in s, refers to the *standard yard* stick in the custody of the l Board of Trade.

e weight of a mass of coal, when expressed in kilo-

grams, refers to the *standard kilogram* of platinum in the Archives of France.

An expression in *cents* of the value of an ounce of quinine sulphate is a number referring to the one-hundredth part of the "dollar," and the *standard dollar* is the actual value of $25\frac{8}{10}$ grains of coin gold, the *standard grain* being the weight of $\frac{1}{1000}$ part of the *actual standard avoirdupois pound.*

Units.

20. **Units** are the terms by which the various kinds of values are expressed. We have units of measurement of length, units of surface measure, units of cubic measure, units of dry measure, units of liquid measure, weight units, monetary units, etc.

These units may be either *standard units* or *subordinate units.*

21. **Standard Units.**—A standard unit is the term used to designate the principal unit of expression or comparison of each kind of measurement, as established by law or custom.

Thus the standard unit of weight of the decimal system is the Gram; the standard units of the liquid measures in the United States are the wine gallon of the old system, and the liter of the new; the standard unit of American money is the dollar; the standard unit of English measures of length is the yard, etc.

22. **Subordinate Units** are simply either multiples or fractional parts of the principal units. Thus the kilogram, meaning 1,000 grams, is a secondary or subordinate unit; the inch is the 1-36 part of the yard; the pint is one-eighth gallon; the cent is 1-100 dollar; etc.

23. It has already been stated that all units of value are necessarily based upon extension (15).

Before this fact became generally recognized there was no

harmony between the several kinds of measures and weights. The standard units were chosen arbitrarily and without reference to each other. Hence the relations between the various units of the old systems of metrology cannot be expressed by any simple numbers or ratios, but are generally represented by odd numbers and interminable fractions.

Thus one wine gallon is 231 cubic inches; one cubic inch of pure water weighs 252·488 grains; one grain of pure water measures 1·0534 minims; etc.

24. **Number of Units of each kind.**—Each branch of trade, profession, or science demands, as a rule, the use of only one or two units. Too many units are burdensome as well as unneccessary. The dollar and the cent are quite sufficient for monetary computations; no one feels the need of a larger unit than the dollar, and the mill only finds a limited use in statistical calculations.

If *one* unit is found to be sufficient for any particular trade or purpose, then that alone should be used for it.

The smallest unit which finds an extensive application is of greater importance than a large one, as fractions should be avoided as far as possible.

25. **Denominations.**—The "denomination" of a weight or coin is its value. Thus we have weights of the following named denominations: 2 pounds, 1 pound, 8 ounces, 4 ounces, one-half ounce, etc.; and coins of the denominations: 20 dollars, 10 dollars, one-half dollar, etc.

The Old Weights and Measures.

26. **Origin of Old Units.**—Instinct and chance led to option of the method of counting which is still in uni- se. Our decimal arithmetic owes its origin to the fact n naturally began their use of numbers by counting on ers, and having counted from one to ten they began

The fingers, the thumb, the palm, the fore-arm (cubit), the fathom, the foot, the stride, "the heighth of a man"—these were the first units of linear measure, adopted solely with reference to convenience. Seeds were used for comparison to express both weight and measure of length. Bulk was expressed in handfuls, pinches, and other equally indefinite units.

The variability as to size of the objects referred to led in due course to the enactment of laws to render the units more definite. Thus it was enacted in England, in the year 1266, that "an English penny, called a sterling, round and without clipping, shall weigh thirty-two wheat corns, from the midst of the ear, and twenty pence shall make an ounce, and twelve ounces one pound, and eight pounds do make a gallon of wine, and eight gallons of wine do make a London bushel, which is the eighth part of a quarter." And in the year 1324 "that three barley-corns, round and dry, shall make an inch, and twelve inches a foot."

27. Then standard yard-sticks, pound weights, etc., were constructed and used as models. Afterwards it was found that the length of the seconds pendulum (vibrating seconds in a vacuum, and at the level of mid-tide in the latitude of London) was equal to 39·13929 of the English inches, the inch being the 1–36 of the yard.

The length of the pendulum being invariable, the length of the inch was then defined to be such as to be contained 39·13929 times in the length of the pendulum.

Upon this constant magnitude rests now the whole system of English and American measures, weights and money.

Had the English inch been slightly diminished, so as to be contained exactly 40 times (instead of 39·13929 times) in the length of the seconds pendulum, our principal unit of linear measure would have borne a comparatively simple relation to that physical constant.

28. All the old standards for weights and measures, each independent of the other, and all gradually adopted into use

by chance, were then connected with the now definite unit of linear extension, the yard of 36 inches.

Laws were enacted defining the value of the other units, as, for instance, the Troy pound was declared to be the weight of 22·794422 cubic inches of distilled water at its maximum density; the wine gallon was fixed at 231 cubic inches; etc.

29. English Units.—In English speaking countries the following units are or have been employed:

Measures of Length.

1 point, equal to 1–72 inch.
1 line, equal to 1–12 inch.
1 barley-corn equal to 1–3 inch.
1 nail, equal to 2 1–4 inches.
1 palm, equal to 3 inches.
1 hand equal to 4 inches.
1 link, equal to 7 92–100 inches.
1 span, or quarter, equal to 9 inches.
1 foot, equal to 12 inches.
1 cubit, equal to 18 inches.
1 yard, equal to 36 inches.
1 ell, equal to 45 inches.
1 fathom, equal to 72 inches.
1 rod, perch or pole, equal to 198 inches.
1 chain, equal to 792 inches.
1 tally, equal to 3,960 inches.
1 furlong, equal to 7,920 inches.
1 cable length, equal to 8,640 inches.
1 mile, equal to 63,360 inches.
1 league, equal to 190,080 inches.

Measures of Capacity.

1 minim, imp. fluid measure, equal to 0·00361 cubic inches.
1 minim, U. S. fluid measure, equal to 0·00376 cubic inches.
1 fluid drachm, imp. measure, equal to 0.21657 cubic inches.
d drachm, U. S. fluid measure, equal to 0.2256 cubic inches.
ounce, imp. measure, equal to 1·73275 cubic inches.

1 fluid ounce, U. S. fluid measure, equal to 1.8047 cubic inches
1 gill, equal to 7·219 cubic inches.
1 pint, wine measure, equal to 28·875 cubic inches.
1 pint, dry measure, equal to 33 6 cubic inches.
1 pint, imp. measure, equal to 34·655 cubic inches.
1 pint, beer measure, equal to 35·25 cubic inches.
1 quart, wine measure, equal to 57·75 cubic inches.
1 quart, dry measure, equal to 67·24 cubic inches
1 quart, beer measure, equal to 70·54 cubic inches.
1 quart, imp. measure, equal to 69·3101 cubic inches.
1 gallon, wine measure, equal to 231 cubic inches.
1 gallon, dry measure, equal to 268.84 cubic inches.
1 gallon, beer measure, equal to 282 cubic inches.
1 gallon, imp. measure, equal to 277·240 cubic inches.
1 peck, equal to 537·6 cubic inches.
1 bushel, equal to 2,150·42 cubic inches.
1 firkin, beer measure, equal to 2,538 cubic inches.
1 barrel, wine measure, equal to 7,276.5 cubic inches.
1 tierce, wine measure, equal to 9,702 cubic inches.
1 barrel, beer measure, equal to 10,152 cubic inches.
1 hogshead, wine measure, equal to 14,553 cubic inches.
1 hogshead, beer measure, equal to 15,228 cubic inches.
1 puncheon, wine measure, equal to 19,404 cubic Inches.
1 puncheon, beer measure, equal to 20,304 cubic inches.
1 pipe, wine measure, equal to 29,106 cubic inches.
1 butt, beer measure, equal to 30,456 cubic inches.
1 tun, wine measure, equal to 58,212 cubic inches.
1 chaldron, dry measure, equal to 77,415.12 cubic inches.

Measures of Weight.

1 grain (troy, apothecary and avoirdupois), equal to 1 grain.
1 scruple, equal to 20 grains.
1 pennyweight, equal to 24 grains.
1 drachm, avoirdupois, equal to 27·344 grains.
1 drachm, apothecary, equal to 60 grains.
1 ounce, avoirdupois, equal to 437·5 grains.
1 ounce, troy and apothecary, equal to 480 grains.
1 pound, troy and apothecary, equal to 5,760 grains.
1 pound, avoirdupois, equal to 7,000 grains.
1 quarter (25 lbs. avoirdupois), equal to 175,000 grains.

1 quarter (28 lbs. avoirdupois), equal to 196,000 grains.
1 hundred-weight, equal to 700,000 grains.
1 hundred-weight (112 lbs. avoirdupois), equal to 784,000 grains.
1 ton (2,000 lbs.), equal to 14,000,000 grains.
1 ton (2,240 lbs.), equal to 15,680,000 grains.

30. Diversity (in value) of units having the same or similar names.—To illustrate the chaos which has existed in respect to the weights and measures of the world we need only compare the various pounds and grains which have been in use in various countries:

Country.	Value of pounds in Grams.	Number of grains in each pound.	Value of each grain in Grams.
France ("livre métrique")	500.	9,216	0·054
Germany (Zollpfund)*	500.	....	....
England and the United States, avoirdupois	452.59+	7,000	0·065—
Sweden†	425.	....	....
Austria	420.	5,760	0·073+
Netherlands and Switzerland	375·	5,760	0·065+
England and the United States; troy and apothecary	373·25—	5,760	0·065—
Amsterdam	371.	....	....
Bavaria and Greece	360.	5,760	0·063—
Poland	358·5	....	....
Russia	358·3	5,760	0·062+
Norway	357·85—	5,760	0·062+
"Nuremburg Pound"‡	357·664—	5,760	0·062+
Sweden	356·25—	5,750	0·061—
Prussia	350·8—	5,760	0·061—
Spain	345·1	6,612	0·050—
Portugal	344·25	....	....
Brazil	344·25	....	....
Tuscany	339·5	6,612	0·049+
Papal States	339·7	....	....
Turin	332·0	6,912	0·048+
Naples and Sicily	320·8	7,200	0·045—
Sardinia	307·4	5,760	0·053+

*Subdivided into 30,000 korns.
†Subdivided into 10,000 korns.
‡Officially recognized in many pharmacopœias, among which were—Finland, Hamburg, Schleswig-Holstein, Russia (Military Pharmacopœia, 1840), Baden, Hanover, Hesse, Bremen, Lubec, Nassau, etc.

Venice	301·2	5,760	0·052+
Mons	279.	....	.
Baden	214·25	....	....

From the above table it will be seen that the pounds and grains varied greatly. The ounces, drachms and scruples of course varied as much.

In addition several of the units above the grain were variously subdivided. Thus most "pounds" were divided into 12 ounces, but others into 16; most "ounces" into 8 drachms, but one of them into 16; most "scruples" into 20 grains, but some into 24.

31. **Intricate relations** between the old units of the several kinds of measures. The confusion of so many different kinds of units, so many units with the same name, though differing in value, and such varying methods of subdivision, is still further increased by the absence of any simple relationship between the units of length, and the measures of capacity and of weight.

To illustrate the want of harmony between the measures of length, capacity and weight, respectively, the following comparisons of English and American units in actual use will suffice:

Measures of Capacity.	Cubic inches.		Pure Water (62° F.); Nearest unit of weight.
1 Imperial Minim	0·00361	....	0·91146 grain.
1 U. S. Minim	0·00376—	....	0·949297 grain.
1 Imp. Fluidrachm	0.21657	....	
1 U. S. Fluidrachm	0·2256	....	0·949297 apoth. drachm.
1 Imp. Fluid ounce	1·73275	....	1 avoirdupois ounce.
1 U. S. Fluid ounce	1·8047	....	0·949297 troy ounce.
1 U. S. or Wine Pint	28.875	....	
1 Imp. Pint	34.655	....	1.25 avoirdupois pound.

Measures of Weight.	Pure Water.
1 Grain, troy	1·053 U. S. Minims.
1 Grain, avoirdupois	1·098 Imp. minims.
1 Drachm, apothecary	1·053 U. S. fluidrachm.
1 Avoirdupois ounce	1 Imp. fluid ounce.
1 Troy ounce	1·053 U. S. fluid ounce.
1 Avoirdupois pound	0·80 Imperial pint.

Efforts towards Reform.

32. Reforms Proposed.—Many propositions have been made to establish simplicity, uniformity and symmetry in the weights and measures of the world.

One of the important points to be gained was to establish a simple relation between linear measure and some invariable standard. It has already been stated (par. 15) that the lengths of the seconds pendulum, and of the meridian, equator and axis of the earth have been considered in this connection. But none of the old established units of measures of length bear any simple relation to either of these standards.

The other improvements necessary include such a subdivision as will bring the notation into harmony with our arithmetic; and a simple relation of the measures of weight to the measures of capacity, through the medium of water, the universal unit of comparison for the expression of the specific weight of liquids.

Proposed Natural Standards.

The Second's Pendulum.—The length of a pendu- ing seconds of time, in the latitude of London, *in* the level of the sea, has been determined to be 39.13929 English inches.

length were to be divided into 40 inches instead of then the one-fortieth of the length of this pendulum furnish an invariable standard unit for measures of which would differ only 2·152 per cent. from our inch- words, if the English inch were made about 2.152 per smaller than it is, ten inches would equal one-fourth of the the seconds pendulum, and our linear measures would a simple relation to a constant of nature.

Seconds' Rod.—A uniform cylindrical rod of iron the level of the ocean and in a locality of unvarying

temperature, performs its vibrations in one second of mean time, is once-and-a-half the length of the theoretic seconds' pendulum in the same latitude. Such a rod would, therefore, in the latitude of London, be 39.13929 x 1½ (if it be assumed that the length of the seconds' pendulum at London is really 39.13929), equal to 58.70893 inches. In a latitude of 45° the length of the seconds' pendulum is, according to Sir Isaac Newton, 39.14912 inches, and the rod, to vibrate in the same time, must accordingly, in that latitude, be 58.72368 inches. The 45th parallel, being the middle term between the equator and the pole, was recommended by the Bishop of Autun, in 1790, as the latitude most likely to be acceptable to all nations to which an universal standard may be referred (36).

35. **The Meridian of the Earth.**—A circle around the earth through its poles is a "meridian," and is practically of invariable length. It was, therefore, recommended by the Dutch astronomer Huygens (1685), as a standard for measures of length. It was actually adopted as the basis of the Metric system in 1791, one-fourth part of a meridian being divided into ten million equal parts and the ten-millionth part called a meter.

36. **The Equator.**—The length of the fourth of the equator, as one of the proposed natural standards, was also considered together with the pendulum beating seconds, and the quarter of the meridian, by the learned committee of the French Academy of Sciences which finally reported on the 19th of March, 1791, in favor of the ten-millionth part of the fourth part of the meridian as the standard unit of linear measure, and recommended the tenth of the seconds' pendulum in latitude 45° as a second standard to be used for comparison with it.

37. **The Polar Semi-Axis.**—The ten-millionth part of the earth's polar semi-axis has also been proposed as a standard, this proposition being favored by Sir John Herschel among others.

Our Arithmetic.

38. Decimal Notation.—Our decimal arithmetical notation undoubtedly had its origin in the fact that man has ten fingers, and that primitive counting consisted in counting on the fingers, and, when the number exceeded ten, beginning over again with a second set of units counted in the same way.

This decimal arithmetic has been handed down to us from prehistoric times, being probably as old as the human race itself. It is a most laborious and imperfect system, and probably destined to be eventually replaced by a better one; but it is universally used at this time, and may continue to be used for centuries.

The number 10 can not be successively divided by 2 until brought down to the number 1, and it comprehends neither the square, nor the cube, nor the fourth power of any number. Hence it is a most inconvenient periodical number for arithmetical notation.

39. Octonary Notation.—In the early part of the 18th century, Emanuel Swedenborg prepared and submitted to King Charles XII, of Sweden, a new system of notation based on the number 8 as the periodical number (counting from 1 to 8 and then beginning over again, as we now count from 1 to 10, and using two figures to write 8 as we now write 10, and three figures to write 64 as we now write 100, etc.). Baron Swedenborg included in his scheme a set of new figures invented by him for this purpose, to prevent confusion with the old, and a set of new names for the new figures. He also applied this new system of arithmetic to cubic calculations, and constructed systems of money, weights and measures accordingly. It is obvious that a unit of length, surface, capacity or weight which can be divided without fractions into 2, 4 and 8 parts is more natural and convenient than one which can not be divided into halves, quarters and eighths. The number 8 is the cube of 2—the number next above unit—and is moreover not too large to be a convenient periodical number for purposes of notation.

Metrology and Arithmetic Harmonized.

40. **System.**—To harmonize our metrology and our arithmetic requires one of two things — either to make our weights and measures decimal to correspond with our arithmetic, as proposed by the metric system; or to construct a new arithmetical notation in harmony with our weights and measures. The latter is an impossible feat, for our weights and measures are not in harmony with each other, nor with any possible system of notation.

The most thorough reform possible should include a new and octonary (or duodenary?) system of arithmetical notation, with new characters and new names, and a corresponding octonary (or duodenary?) system of measures, weights and money.

41. **Difficulties in the Way of Reform.**—Aversion to any change which necessarily calls for the temporary application of the least amount of exertion of the mental faculties is the most formidable obstacle to any reform in weights, measures and money. Hence it would really make but little difference whether the proposed *new* varies much or little from the existing *old*; it meets with opposition first and last because it is new and because it is a change. Specific objections against any change have been offered and are being constantly repeated; but they have been fully answered.

One objection is that new names are difficult to introduce, but new names must come with any material change, for new units with old names are far more objectionable, causing unavoidable confusion.

42. **Compromises.**—It has been frequently proposed and even actually attempted to construct new systems of weights and measures which shall be in harmony with the universal system of arithmetic as to the subdivisions and multiples of the several denominations, and at the same time retain some part of the old system as a connecting link. The subdivisions of the units of the old systems are sometimes by 2, sometimes by

3, 4, 10, 12, and various other numbers; but we can easily apply decimal subdivision to any one unit. The several units, multiples and subdivisions of the old systems of weights and measures, however, are not only at variance with our arithmetic but they are incommensurable each with the other throughout the whole system, and they cannot be harmonized with our arithmetic nor with each other, because to materially change them is to abolish them.

Decimal Weights, Measures and Money.

43. There have been many decimal systems of weights and measures proposed and used. Among those based upon invariable standards are the following:

THOMAS JEFFERSON'S DECIMAL SYSTEM.

44. This decimal system antedates the metric system. It was submitted to the House of Representatives of the United States, July 13, 1790, by Mr. Jefferson, who was then Secretary of State.

Doubtless Mr. Jefferson, while resident in Paris as the Minister of the United States during the great Revolution, had become familiar with and inspired by the grand ideas and schemes for the improvement of the condition and happiness of mankind, which, during that period, coming from all parts of the civilized world, found expression in France. Among these great ideas was that of establishing one language of weights, measures and money for the whole world, and the plans proposed by the greatest philosophers then living, and by those who preceded them, were thoroughly discussed.

Mr. Jefferson's report to Congress was finished "about the 20th May," 1790.

He proposed as a standard the length of the seconds rod

in latitude 45° which was assumed to be 58.72368 inches (34), and one-fifth of which was to be the basis of the new system. This he called a new "foot." The new foot was, as will be seen, only about one quarter of an inch shorter than the old. He proposed to divide the new foot into 10 inches, each inch into 10 lines and each line into 10 points; 10 feet was to be called a decad, 10 decads a rood, 10 roods a furlong, and 10 furlongs a mile.

The new cubic foot was made a bushel, equal to about 1620 English cubic inches, furnishing the basis for measures of capacity.

The new cubic inch of pure water was proposed as the basis for the new standard of weight, the weight of that volume of water being called an ounce.

Finally, one new ounce of silver, $\frac{11}{12}$ fine, was to be the new dollar.

This system was practically as meritorious as the metric system in all essentiai respects but was not adopted.

THE POLAR SYSTEM.

45. The Earth's axis is a little over 500 million inches. One five-hundred-millionth part, called a polar inch was recommended by Prof. H. Hennessey, F.R.S., as the basis of a new decimal system. This new inch would be equal to 1.000967 English inches. The "polar link" was to contain 10 polar inches; the "polar quart" proposed was to be the cube of ½ polar link, equal to 2·0539 liters; and the standard unit of weight of this system was to be the "stat," equal to the weight of $\frac{1}{1000}$ polar quart of pure water.

THE METRIC SYSTEM.

46. This system was not the work of any one mind, nor of

wish to avoid the use of fractions, then the simplest and most effective method would be to use only grams and milligrams for weights. But, we have no metric unit of fluid measure commensurate with the milligram, nor even with the centigram.

86. The **gram** and the **cubic-centimeter** are in fact the only commensurate small units of the metric system which are available for use in medicine and pharmacy, and if these two are alone used decimal fractions become unavoidable. The only way to avoid decimal fractions in using the metric system in medicine and pharmacy is to invent and use a new unit of fluid measure commensurate with either the milligram or the centigram; but for purposes of dividing and stating doses, and for writing prescriptions, a unit of fluid measure corresponding to the milligram would be too small, and if one corresponding to the centigram were adopted we would at once sacrifice the perfect analogy between the units of weight and the units of measure unless the centigram itself be used as a weight unit.

87. Careful reflection upon the question in all its practical bearings leads us to the conclusion that about two or three units of each kind will be necessary in order to avoid fractions to the greatest practicable extent, and that the smallest unit of fluid measure must then be as nearly the weight and volume of an ordinary drop of pure water as possible whilst the smallest unit of weight should be still less.

88. To construct a perfect system of weights and measures for medical and pharmacal purposes we must first of all fix upon the most practical smallest unit for fluid measure, and then adjust the rest to correspond.

89. **The minim** has been found by long experience to be as nearly perfect as any unit of fluid measure can be for the purposes for which it is used. and it is to be regretted that no unit of the metric system is equally appropriate. Its nearness to the average drop is a powerful argument in its favor, be-

glass-ware hereafter furnished the medical officers, will be in accordance therewith.

Simple rules for the ready conversion of terms of the United States Apothecaries' Weights and Measures into their respective equivalents in metric terms are appended, which for all medical and pharmacal purposes, are believed to afford sufficiently accurate results. Suggestions are also given as to the mode in which metric medical prescriptions might be constructed, and in relation to the preparation of requisitions for medical supplies in metric terms.

JOHN M. WOODWORTH
Surgeon-General U. S. M.-H. S.

Approved: JOHN SHERMAN, *Secretary of the Treasury.*

Weights and Measures in Medicine and Pharmacy.

48. The Metric System in Medicine and Pharmacy.—The metric system is now used in the pharmacopœias of Austria, Belgium, Denmark, France, Germany, Greece, Mexico, Norway, Russia, Sweden, Switzerland, and the United States. In the last named pharmacopœia, however, the troy grain is also used in part.

Many of the best works on chemistry, pharmacy, and materia medica in all languages now use the metric system.

49. Relative Accuracy of Weighing and Measuring.—In general it may be assumed that weighing, when done with extreme care and with exceptionally good balances and weights, is more accurate than measuring. This is especially true in operating with large quantities, as in manufacturing, in selling at wholesale, or in handling freight. For the purposes named, measuring is very inconvenient if not altogether impracticable.

For ordinary pharmaceutical operations, however, measuring, when applied to liquids, is at least equally as accurate as weighing if not more so, and for these purposes it is far more convenient.

The variances due to differences in quality and strength and to the necessarily uncertain and arbitrary dosage of medi-

Every man for himself can, however, make use of such approximate equivalents as may be safe and convenient, and the best method, in the writer's opinion, is to consider 32 grams equal to 1 troy ounce, and 1 gram equal to 16 grains; and, reciprocally, 32 fluigrams (or cubic-centimeters) equal to 1 fluid ounce and 1 fluigram (or cubic-centimeter) equal to 16 minims.

93. Should these reciprocal relations between the ounces, grain and minim, and the gram and cubic-centimeter, be formulated into a new system of medical and pharmacal weights and measures, including as its units an ounce of 32 grams, a grain of $\frac{1}{16}$ gram, a fluidounce of 32 cubic-centimeters, and a minim of $\frac{1}{16}$ cubic-centimeter, the old grain weights, and our U. S. fluid measure graduates could very well continue to be utilized until gradually replaced, as the differences in value between the old and the new would be absolutely insignificant for all medical and pharmacal purposes.

The Strength of Liquid Pharmacal Preparations.

94. Both the apothecaries' weights and measures and the metric system have defects, which become apparent in their practical application. The reasons for this are that each lacks some of the requirements necessary to the greatest degree of clearness, simplicity, convenience and safety for pharmaceutical uses, which are as follows:

(*a.*) Binary subdivision.

(*b.*) Parallel and commensurable units of weight and measure. All the units of weight should have their corresponding ing equivalents among the units of fluid measure, with reference to water at ordinary temperature, except that no unit of fluid measure smaller than one corresponding to about the grain would be useful. Thus, the fluid-ounce and ounce, the fluidrachm and drachm, the grain and minim, the liter and kilogram, the cubic-centimeter and Gram, of pure water at 22.° C. (71.° 6 F.) should coincide.

(*c.*) The subdivision of all the units, respectively, should be the same, as is the case in the decimal system; or the num-

· *of units* contained in the next larger should at least, to a *xtent, be divisible* by the same numbers throughout the *bus: If the* number of drachms in the ounce be 8, then

51. Parts by Weight.—The method of stating pharmaceutical working formulæ in "parts by weight," instead of prescribing definite quantities expressed in named weight units, is very efficient. It leaves the choice of weights entirely free, as any weight unit whatever can be substituted for the abstract expression "part," permitting not only a choice between the weight units of the several systems, old or new, but also a choice of the most suitable weight as to size or value.

The official formula of the Pharmacopœia of the United States for compound powder of glycyrrhiza will serve to illustrate the case clearly, thus:

PULVIS GLYCYRRHIZÆ COMPOSITUS.

Senna, in No. 60 powder, *eighteen parts*	18
Glycyrrhiza, in No. 60 powder, *sixteen parts*	16
Fennel, in No. 60 powder, *eight parts*	8
Washed Sulphur, *eight parts*	8
Sugar, in fine powder, *fifty parts*	50
To make one hundred parts	100

Rub them together until they are thoroughly mixed.

If the operator desires to prepare only 100 grains of this preparation he may put in the word *grains* instead of "parts" whenever the last mentioned expression occurs, using 18 grains of senna, 16 grains of glycyrrhiza, 8 grains each of fennel and washed sulphur, and 50 grains of sugar.

52. Among the units of weight at our disposal to be put in place of the word "parts," we have:

The MILLIGRAM, which would make the final product equal to about	1½	grains.
The CENTIGRAM, which would make the final product equal to about	15	"
The GRAIN, which would make the final product	100	"
The DECIGRAM, which would make the final product about	150	"

The GRAM, which would make the final product equal to about	3⅓	troy ounces.
The SCRUPLE, which would make the final product	4⅙	"
The DRACHM, which would make the final product	12½	"
The DEKAGRAM, which would make the final product equal to about	32	"
The AVOIRDUPOIS OUNCE, which would make the final product equal to about	91	"
The TROY OUNCE, which would make the final product	100	"
The HEKTOGRAM, which would make the final product equal to about	231	"
The AVOIRDUPOIS POUND, which would make the final product	100	pounds.

Extensive as this assortment of units is, and as each may be taken one-fourth, one-half, one, two, three or four times, the final product may be made to correspond near enough to any definite quantity desired.

Those who do not wish to employ metric weights can use the grains, scruples, drachms, ounces or pounds, and *vice versa*.

53. Another advantage of the method of expressing proportions in parts by weight is, that, as it does not give preference to any one system of weights and measures over any other, it does not arouse useless controversy over their respective merits.

It is to be clearly observed, however, that it is quite as easy to substitute either of the words "grains," "drachms," or "ounces," or the word "parts" for the word "gram;" or either of the words "parts" or "gram" for the word "grain" or "ounce"; as it is to substitute the name of any weight unit for the word "parts." In other words, the method of expressing proportions in parts by weight has absolutely no real advantage over the method of stating actual quantities, *provided but one unit is referred to*, except that it cannot excite the prejudice of those who strenuously labor for the exclusive use of some one system of weights to the exclusion of every other system.

54. A formula expressed in parts by weight is simply an abstract formula, a rational or proportional formula; an actual working formula must be expressed in definite quantities.

55. **Numerical Proportions of Ingredients.**—The Pharmacopœia of the United States, and other Pharmacopœias, express the quantities or parts by weight of the ingredients entering into a composition in the simplest possible terms, but at the same time in a decimal, centesimal, or millesimal ratio, if possible. The U. S. Pharmacopœial Convention of 1880 decided that "all such tinctures, wines, etc., in which a slight variation of dose is of no importance, shall be made as nearly as possible of a uniform percentage strength; that is, 1 part of the drug shall be made into 5 parts of tincture, or into 10 parts of tincture, as the case may be."

In other words, the proportional strength of medicinal preparations is fixed according to a purely mathematical ratio, and in accordance with the universal decimal arithmetic. The tinctures of the U. S. Pharmacopœia accordingly represent the active principles of 5, 10, 15, 20, 40 and 50 per cent. of the drug; syrup of rubus represents 20 per cent. blackberry root; syrup of ipecac 5 per cent. of ipecac; etc. But we also find preparations of 2, 3, 4, 8, 33, and other percentages of proportional strength.

The number per cent of course refers to weight.

56. The advantages to be derived from "uniform (?) percentage strength" are not readily appreciated. Beyond the fact that the formulæ have a more finished appearance (mathematically), and that *the percentage strength* is seen at a glance, there is perhaps nothing to commend this rule. It has the great disadvantage that it is quite out of harmony with the universal, and, in fact, unavoidable method of measuring the doses of liquid preparations, which requires that the active contents of a conveniently measured dose shall be readily ascertained.

The knowledge that tincture of aconite is of forty per cent. strength by weight conveys no clear idea of its strength by measure; that *liquor pepsini* contains 4 per cent. saccharated pepsin does not indicate what its proper dose is.

57. **Solids by Weight, Liquids by Measure.**—There

Ten (new) grains to each (new) fluid ounce.

This is equal to:

10 Grams to each 16 (new) fluid ounces, or
$1\frac{1}{4}$ (new) grains to each (new) fluidrachm, or
$\frac{10}{480}$ (new) grain to each fluigram, or
$\frac{10}{1920}$ (new) grain to each 4 (new) minims, or
$\frac{10}{7680}$ (new) grain to each (new) minim, or very nearly 1·99 per cent. if of the sp. gr. 1.000).

Twelve (new) grains to each (new) fluid ounce.

This is equal to:

12 Grams to each 16 (new) fluid ounces, or
$1\frac{1}{2}$ (new) grains to each (new) fluidrachm, or
$\frac{3}{40}$ (new) grain to each fluigram, or
$\frac{3}{512}$ (new) grain to each 4 (new) minims, or
$\frac{3}{1920}$ (new) Grain to each (new) minim (or very nearly 2·24 per cent , if of the sp. gr. 1.000).

Sixteen (new) grains to each (new) fluid ounce.

This is equal to:

16 Grams to each 16 (new) fluid ounces, or
1 Gram to each (new) fluid ounce, or
2 (new) grains to each (new) fluidrachm, or
$\frac{1}{2}$ (new) grain to each fluigram, or
$\frac{1}{8}$ (new) grain to each 4 (new) minims, or
$\frac{1}{32}$ (new) grain to each (new) minim (or very nearly 3.12 per cent., if of the sp. gr. 1.000).

Twenty-four (new) grains to each (new) fluid ounce.

This is equal to :

24 Grams to each 16 (new) fluid ounces, or
$1\frac{1}{2}$ Grams to each (new) fluid ounce, or
3 (new) grains to each (new) fluidrachm, or
$\frac{3}{4}$ (new) grain to each fluigram, or
$\frac{3}{16}$ (new) grain to each 4 (new) minims, or

62. In other liquid medicinal preparations, however, such as mixtures, solutions, tinctures, etc., the rules governing proportional strength should be fixed with regard chiefly to their uses —the manner of prescribing and administering them,—which is of greater practical importance than the attractiveness and the merely superficial simplicity of decimal mathematical proportions.

63. Fortunately, it is not difficult to make simple and practical rules for the proportional strength of liquid pharmacal preparations, in harmony with the decimal system as well as with binary subdivision, with the old as well as with the new system of weights and measures, and, above all, consistent with the purposes for which these preparations are made and the manner in which they must necessarily be used. Any effort in this direction involves the use of fluid measures and hence we can not expect to have a natural, easy, and accurate system of making, prescribing and using liquid medicinal preparations unless fluid measures are completely restored in the Pharmacopœia.

64. Since the number 1,000 can be divided into halves, quarters, eighths, and even sixteenths, without doing any violence to the decimal system, it becomes very easy to combine in a practical way the advantages of both decimal and binary subdivision with the volumetric system for all liquid preparations.

65. Let 1,000 Cubic-centimeters of the liquid preparation represent either 1,000, 500, 250, 125, or 62.5 Grams of the drug. This would give us preparations of the following proportional strength:

Fluid extract strength, or normal.
One-half fluid extract strength, or half-normal.
One-fourth fluid extract strength, or quarter normal
One-eighth fluid extract strength, or eighth-normal.
One-sixteenth fluid extract strength, or sixteenth-normal.

66. All preparations having the same specific weight as water

would of course be exactly 100, 50, 25, 12.5, and 6.25 per cent. strength by weight. At the same time each cubic centimeter would represent, respectively, 1 gram, ½ gram or 50 centigrams, ¼ gram or 25 centigrams ⅛ gram or 125 milligrams, and $\frac{1}{16}$ gram or 625 milligrams. These simple ratios ought to prove satisfactory to the advocates of decimal proportions and the friends of the metric system, and equally satisfactory to those who are unwilling to sacrifice fluid measures, unwilling to sacrifice binary subdivision, and unwilling to adopt the metric system, because, as will now be shown, these proportions can be preserved without any sacrifice on either side, permitting the use of either metric weights and measures, or the old and more familiar systems.

67. One Cubic-centimeter of pure water weighs one Gram. Now, if it can be found that one fluid ounce practically or closely enough equals one ounce, that one fluidrachm weighs sufficiently near one drachm, and that one minim is very nearly one grain then the problem before us is easily solved.

68. If we should use the avoirdupois ounce and the Imperial fluid ounce of England, then the proportions already stated, representing fluid extract strength, and one-half, one-fourth, one-eighth, and one-sixteenth of that proportional strength, would be exactly expressed as follows in avoirdupois and Imperial fluid-ounces :—

Use 16 avoirdupois ounces to make 16 imperial fluid ounces.
Use 8 avoirdupois ounces to make 16 imperial fluid ounces.
Use 4 avoirdupois ounces to make 16 imperial fluid ounces.
Use 2 avoirdupois ounces to make 16 imperial fluid ounces.
Use 1 avoirdupois ounce to make 16 imperial fluid ounces.

But the Imperial fluid measure and the avoirdupois weights are commensurate only in the ounces; the minim and grain do not correspond.

One Imperial fluid ounce would represent, respectively, 1, ½, ¼, ⅛ and $\frac{1}{16}$ avoirdupois ounce of the drug; one Imperial

fluidrachm would represent nearly enough 56 grains, and 28, 14, 7 and 3½ grains respectively; and 100 Imperial minims would represent nearly enough, 90, 45, 22, 11 and 5½ grains. These proportions are the same as have been in actual use in Great Britain for a quarter of a century. They are awkwardly intricate; yet, they are more readily intelligible in the ascertainment of the strength of pharmacal preparations than any system which excludes fluid measure.

The advantage of having the fluidounce commensurate with the avoirdupois ounce is more than neutralized by the fact that the avoirdupois grain does not correspond with the minim, whence the odd numbers and the fractions.

69. Now let us turn to the troy ounce and grain and the U. S. fluid ounce and minim, and see how nearly the same proportions can be carried out with this mixed system without awkward fractions.

One U. S. fluidounce of pure water at + 16.67° C. (62° F.) weighs 0·949297 troy ounce; one U. S. fluidrachm weighs 0·949297 drachm; and one U. S. minim weighs 0·949297 grain. Here, then, we find a constant difference of very nearly five cent. between the relation of metric fluid measures to metric weights, and the relation of U. S. fluid measures to U. S. Apothecaries' weights. This difference can safely be ignored; it amounts to no more than if $\frac{1}{19}$ grain of strychnine should be used instead of $\frac{1}{20}$ grain, or if 19 powders should be made instead of 20 out of the same quantity, or if the patient should use a spoon five per cent. larger or smaller than was supposed. It is an absolutely insignificant difference in comparison with the deviations resulting from prescribing liquids by weight which must be taken by measure. The changes of strength introduced through the last revision of the U. S. Pharmacopœia were far greater.

70. Practically, therefore, it would make no appreciable difference if the Pharmacopœia should fix the strength of fluid extracts, tinctures, etc., so that one liter shall represent 1,000,

500, 250, 125, or 62·5 Gm, respectively, with the express understanding that these proportions may be considered as equal to making 16 fluid ounces from 16, 8, 4, 2 or 1 troy ounces, or 16 fluidrachms from 16, 8, 4, 2 or 1 drachms, or 16 minims from 16, 8, 4, 2 or 1 grains, the actual difference being less than five per cent.

Of course no change of strength ought to be made, however small, in any medicinal preparation, or in medicinal weights and measures, unless established by common consent or by authority.

Practical View of the Relations of the Metric and the Old Systems to each other.

71. If a new system of weights and measures for medical and pharmacal purposes were desirable—one which combines the old and the new, one based upon the standards of the metric system, and yet admitting of the use of our old familiar ounces, minim and grain—it could easily be constructed.

72. As has elsewhere been stated (169) the United States has no medical and pharmacal weights and measures of its own. We borrowed the troy ounce and grain from England, and also the fluid ounce and minim based on the English wine gallon. But these weights and measures were abolished in Great Britain many years ago. The statutes of the United States contain nothing which fixes the value of either of these units, and their use is not specifically authorized by law, but simply permissive by common law. Hence legislation on this subject is needful, and it would be well for pharmacists and physicians to carefully consider what weights and measures may be in every way best adapted for the peculiar uses and conditions of practical medicine and pharmacy in order that, whenever this necessary legislation may be undertaken, we might be properly prepared for wise action.

7 . If neither the Metric System nor the old Apothecaries' Weights and Measures can be regarded as perfectly adapted for the purposes of the physicians and pharmacists, then there should be no hesitation to construct and adopt an entirely new system, provided a system more nearly perfect than any of the known systems can be devised.

A sudden and great change in our weights and measures would naturally be attended with much labor and inconvenience ; but if the new units can be made to resemble the old so nearly that no considerable disturbance or disadvantage could result from using the old instead of the new ounce or grain, or *vice versa*, and if the improvements sought by the change are still accomplished, then the problem is practically solved.

74. If our grain were exactly $\frac{1}{16}$ Gram, it would be only $\frac{1}{271}$ smaller than it now is ; and if our troy ounce were equal to exactly 32 Grams it would be $\frac{1}{32}$ larger than it now is. As to our fluid measures, if our minim were exactly $\frac{1}{16}$ Cubic-centimeter, it would be only $\frac{1}{70}$ larger than it is ; and if our fluid-ounce were equal to exactly 32 Cubic-centimeters, it would be only $\frac{1}{13}$ larger than it is.

These equivalents are the same that were formally adopted by the U. S. Marine-Hospital Service, April 27, 1878, and which have since been recommended, republished, and used by some of the highest authorities in medicine and pharmacy in this country, with the only exception that instead of the proposition to consider one Gram equivalent to 15 grains (the actual equivalent being 15.43234874 grains), and 1 Cubic-centimeter equivalent to 15 minims (the actual equivalent being 16.231 minims), it is here proposed to substitute the number 16 for 15.

75. If this practical view of the relations of the old weights and measures to the Metric System be accepted, then we at once have a most convenient bridge between the old and the new ; and yet, the differences in value between these *proposed*

minims had been given instead of only 70, and *vice versa*. All the more powerful remedies are prescribed by grains and minims.

The old drachm of 60 grains would be less than $\frac{1}{30}$ smaller than the new drachm of 64 grains, because the new grain would be proportionately lighter than the old, 60 of our present grains being equivalent to 3.888 Grams, whereas the proposed new drachm would be equivalent to 4 Grams, a difference of only 2.8 per cent.

Whenever a troy ounce is prescribed and a new ounce (32 Grams) dispensed, the difference is an excess of about 13 grains, and *vice versa*. If, however, a new fluidounce is dispensed instead of an old U. S. fluidounce, the excess amounts to as much as if we should make a fourteen ounce mixture when only a thirteen ounce mixture had been intended, and *vice versa*.

These differences are so insignificant that they ought not to be permitted to stand in the way of harmonizing our weights and measures on this convenient basis.

100. Subdivisions by 3, 6, 12, and 24 are of comparatively little value in the apportionment of doses of medicine provided the smallest units of weights and measures are sufficiently small. As already stated the minim is probably small enough. As to the grain, it would be well, when this matter shall finally receive the attention it craves, to carefully consider the utility of one smaller unit. If the grain should be divided into 64 equal parts, each such part would be almost exactly eqnal to one milligram, which would be a decided advantage; at the same time the number 64 contains the square of 8, the cube of 4, and the sixth power of 2, and $\frac{1}{64}$ grain is probably a sufficiently small weight unit for medical and pharmacal purposes. Our best prescription scales are probably not sensitive to less less than $\frac{1}{20}$ or even $\frac{1}{16}$ grain; but the subdivision of doses occasionally extends beyond even so small a fraction as the sixty-fourth part of the grain.

A smaller unit than one corresponding to the sixty-fourth part of a grain would probably be less useful than it.

It may be fairly concluded that medicine and pharmacy have advanced beyond that stage at which the grain can be regarded as an adequate smallest unit of weight.

III. METRIC SYSTEM OF WEIGHTS AND MEASURES.

101. **Characteristics.** 1. The Metric System rests upon an invariable basis (see par. 15.).

2. Its construction is in perfect harmony with our arithmetical notation, the multiples and subdivisions of its units being in decimal progression.

3. The units of the several kinds of measures of the metric system are commensurable with each other, respectively, all of them being derived from the same primary unit, the meter.

4. The connecting link between the measures of extension and the measures of weight, of the metric system, is the standard of comparison for specific weight (water).

102. **Basis.** The quadrant (or one-fourth) of the earth's meridian, or the distance from the equator to the pole as measured along the surface of still water.

103. **Primary Unit.** The quadrant of the meridian is divided into ten million parts, and the ten-millionth part is called a *Meter*. The Meter, or ten-millionth part of the distance from the equator to the pole, is the primary unit of linear measure of the metric system of weights and measures.

104. **Derivation** of the words "Meter," and "Metric System." The word *Meter* is derived from the Greek *μέτρον*, measure, and the name "metric system" from the word "meter," which is the primary unit.

105. **Standard Units of the Metric System.** The metric system has in reality but one unit for each kind of measures.

106. The **Meter** is the unit of measures of length.

107. The squares upon the linear measures are used for the measurement of surface.

The square of ten meters (one dekameter), called an **Are**, is the unit of land measure.

108. The cubes upon the linear measures are used for the measurement of capacity and bulk.

The **Stere**, or cubic meter, is the cube upon one meter and is used for measuring large bulks of dry substances.

The cube upon one-tenth of a meter (one decimeter), called a **Liter** is the unit for liquid and dry measures.

The Cubic-centimeter. The cube upon one one-hundredth part of a meter, called a "cubic-centimeter," is equal to one milliliter (the Liter being one cubic-decimeter).

109. The weight of one one-thousandth part of a liter of pure water at 4°C., (39°2 F.), *in vacuo*, called a **Gram**, is the unit of measures of weight.

As one cubic-centimeter of pure water, at 4.°C., weighs one Gram, therefore—

1 Liter=1,000 Cubic centimeters=1,000 Grams (of pure water at 4°C.).

110. **Subordinate Units of the Metric System.** All the standard units enumerated in the preceding paragraphs, when multiplied or divided by 10, 100, 1,000; or 10,000 furnish other units of a subordinate character. The names of these subordinate units are made up of the names of the standard units and certain numerals in the form of prefixes..

111. **Prefixes** used in connection with the units of the metric system :

Myria-, meaning ten thousand.
Kilo-, meaning one thousand.
Hekto-, meaning one hundred.
Deka-, meaning ten. And

[illegible] meaning one-tenth.
[illegible] meaning one-hundredth.
[illegible] meaning one-thousandth.

[illegible] myriagram, therefore, means a ten-thousand-gram; and 5.6 myriagrams means five ten-thousand-grams and six tenths of a ten-thousand-gram, or fifty-six thousand grams.

A kilometer is a one-thousand-meter; three kilometers is three one-thousand-meters, or three thousand meters; and three kilometers is three one-hundredths of one one-thousand meters, or thirty meters.

A hektoliter is a one-hundred-liter measure; and 3.5 hektoliters is three one-hundred-liters and five-tenths of one one-hundred-liter, or three hundred and fifty liters.

A dekagram is one ten-gram; and two dekagrams is two ten grams, or twenty grams.

A deciliter is a one-tenth liter; and 8.7 deciliters is eight one-tenth liters and seven-tenths of one one-tenth-liter, or 8.7 liters.

A centigram is one one-hundredth-gram; five centigrams is five one-hundredth-grams; and ten centigrams is ten one-hundredth grams, or ten hundredths of one gram, or one tenth of one gram.

A *milli*meter is one one-thousandth-meter; 25 millimeters is twenty-five one-thousandth-meters, or twenty-five one-thousandths of one meter.

113. **Derivation of Prefixes.** Those prefixes which denote multiples are simply the Greek numerals: "Kilo," thousand; "Hekto," hundred; and "Deka," ten.

The prefixes denoting subdivisions of the standard units are the Latin numerals: "Deci," one tenth; "centi," one-hundredth; and "milli," one-thousandth.

114. **The Prefixes not essential parts of the Metric**

System. It has already been stated that the real units of the metric system are the Meter, the Are, the Liter, the Stere, and the Gram. The prefixes used to indicate multiples and subdivisions of these units are convenient, and as there are only seven of them they should be thoroughly committed to memory. But they are not at all essential parts of the whole system, for other numerals would subserve the same end. The choice of expression will be governed by euphony, brevity, and convenience. Most persons would rather say "ten grams" than "one dekagram;" but it is, on the other hand, more convenient to say "one centigram" than "one one-hundredth part of a Gram."

115. Orthography of the Denominations of the Metric Units. In France the names of the metric units are written: Mètre, Litre and Gramme. In Germany they are written: Meter, Liter, and Gramm.

The Swedes write: Meter, Liter, and Gram.
The Spanish write: Gramo.
The Russians: Gramma, etc.

116. Thus all nations that are using the metric system of weights and measures modify the orthography of the names of the units of that system in accordance with their own languages.

The natural English spelling of the metric units would, therefore, be Meter, Liter, and Gram.

The Pharmacopœia of the United States has adopted the English spelling for the "Meter" and "Liter," but the French spelling for the "Gramme."

117. Abbreviations. The abbreviations of the names of the several metric units are unfortunately diverse.

The	Micromillimeter has been written	μ
"	Millimeter "	mm, Mm, and 0.001 M.
"	Centimeter "	cm, Cm, and 0.01 M.

The	Decimeter has been written	dm, Dm, and 0.1 M.
"	Meter "	M., m., met , and 1 m.
"	Dekameter "	DM, dm, dekam., and 10 M.
"	Hektometer "	Hm, hm, hectom., and 100 M.
"	Kilometer "	Km, km, kilom., and 1000 M.
"	Square Meter "	Sq. m., and m^2.
"	Are "	Are, and 100 m^2.
"	Hectare "	H. Are, and 10,000 m^2.
"	Cubic Meter "	Cub. M., m^3, and M^3.
"	Cubic Decimeter "	dm^3.
"	Cubic Centimeter "	C.c., c.c., cc, ccm, cub. cent., cm^3, cbc, etc.
"	Kiloliter "	K.lit., or Kilol, or 1,000 L.
"	Dekaliter "	Dl, and dl, or 10 L.
"	Liter "	L, l, and lit.
"	Deciliter "	dl, Dl, and decil., or 0.1 L.
"	Centiliter "	cl, Dl, and centil., or 0.01 L.
"	Milliliter "	ml, Ml, C.c., ccm, and millil., or 0.001 L.
The	Kilogram has been written	KG, KGm, Kilogr, kg, kgm, etc., or 1,000 Gm.
The	Hektogram has been written	HG, HGm, hektogr., hg, hgm, etc., or 100 Gm.
The	Dekagram has been written	DG, DkGm, Dekagr., dg, dgm, etc., or 10 Gm.
The	Gram has been written	G., g.. Gm, Gram, Gramme, etc.
"	Decigram "	dg, Dg, decigr., dGm, etc., or 0.1 Gm.
The	Centigram has been written	cg, cGm, Cg, Centigr., etc., or 0.01 Gm.
The	Milligram has been written	mg, mGm, Mg, Milligr., etc., or 0.001 Gm.

118. The abbreviations adopted by the Pharmacopoeia of the United States are: C.c. for Cubic-centimeter, and Gm for Gram.

119. **The Units necessary for actual use.** For the special uses of each branch of science, art, profession or commerce, only one or two, or at all events very few units of the metric system are practically sufficient.

The only metric weight units necessary in medicine and pharmacy are the Gram, the Centigram, and the very useful Milligram. The grocer needs the Kilogram and the Dekagram.

120. The only metric measures of capacity applicable in pharmacy are the Liter and the Cubic-centimeter; the grocer, however, would use the Liter almost exclusively.

121. The land surveyor would write Kilometers and Meters; the dry-goods merchant would find the Meter and the Centimeter sufficient; the draughtsman would use Millimeters; and the microscopist, micro-millimeters.

122. **Familiar Names for Metric Units.** It is very important that the principal units should be known by heart. These are: The METER for measures of length; the LITER and the CUBIC-CENTIMETER for measures of capacity; and the GRAM for weights.

123. It would greatly facilitate the introduction of the Metric System in medicine and pharmacy if physicians and pharmacists would dismiss from their minds all the rest of the units, names, and prefixes of the metric system, except the units named in paragraph 122 and the familiar terms *cents* and *mills*, which mean *hundredths* and *thousandths*.

124. In fact, the metric weights and measures for medical and pharmacal purposes might be limited to the GRAM and the FLUIGRAM;* larger units than these are unnecessary; and the tenths, hundredths and thousandths of the GRAM and FLUIGRAM might well be called *dimes*, *cents* and *mills* for convenience.

125. **How to Write Metric Quantities.** The usual method is to express quantities in the principal units and decimal fractions. Thus 35 centigrams is written 0.35 Gm; 2 kilo-

* To express the analogy between the Gram and the Cubic-centimeter the term Fluigram was recommended for the cubic-centimeter by Mr. Alfred B. Taylor of Philadelphia.

grams 3 dekagrams and 7 milligrams is written 2,030.007 Gm; 165 centigrams is written 1.65 Gm; and 15 grams 4 decigrams 3 centigrams and 2 milligrams is written 15.432 Gm.

126. Mistakes have frequently resulted from ignorance of decimal fractions, and from such careless writing that the *decimal point* was not clearly legible. The best and safest way would be to use no decimal point at all, but to write only whole numbers and designate the denominations or fractions in words. Instead of writing 0.001 Gm, 0.015 Gm, or 0.65 Gm, we should write 1 mill, 15 mills, and 65 cents, or 1 milligram, 15 milligrams, and 65 centigrams.

127. In writing metric quantities Roman numerals are never used, but the common Hindu or Arabic numerals. Moreover, the denominations to which the numbers refer are put *after* the numbers. Thus, we write 10 Gm, but never

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THE METRIC UNITS.

MEASURES OF LENGTH.

is the thousandth part of the meter, or 0.001 meter.
is the hundredth part of the meter, or 0.01 meter.
is the tenth part of the meter, or 0.1 meter.

r is ten meters.
ter is one hundred meters.
r is one thousand meters.

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is 1 centimeter.
is 1 decimeter.
1 meter.
meter.
ektometer.
ilometer.

---

ual to 0.001 millimeter.

Equivalents in English Measures.

1 Meter is equal to 1·093623 yards.
1 Meter is equal to 3·280869 feet.
1 Meter is equal to 39·370432 inches.

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1 Decimeter is equal to 0·1093623 yard.
1 Decimeter is equal to 0·3280869 foot.
1 Decimeter is equal to 3·9370432 inches.

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1 Centimeter is equal to 0·01093623 yard.
1 Centimeter is equal to 0·03280869 foot.
1 Centimeter is equal to 0·39370432 inch.

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1 Millimeter is equal to 0·001093623 y rd.
1 Millimeter is equal to 0·003280869 foot.
1 Millimeter is equal to 0·039370432 inch.

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1 Micromillimeter is equal to 0.00003937 inch.

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1 Kilometer is equal to 1,093·623 yards.
1 Kilometer is equal to 3,280·869 feet.
1 Kilometer is equal to 39,370·432 inches.

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1 Hektometer is equal to 109.3623 yards.
1 Hektometer is equal to 328·0869 feet.
1 Hektometer is equal to 3,937.0432 inches.

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1 Dekameter is equal to 10.93623 yards.
1 Dekameter is equal to 32.80869 feet.
1 Dekameter is equal to 393.70432 inches.

128. The Meter. The meter is about ten per cent. longer than the yard, or approximately 40 inches.

129. To Convert Meters into Inches: ***Add 10 per cent. and multiply by 36.***

The answer will be too great by 19.13 feet for every 1000 meters, or about one-half per cent. If one-half per cent. be deducted from that answer, the remainder will be too great by only about 2½ feet for every 1,000 meters, or one-thirtieth inch for every meter. *Ex.:* To find the number of inches equivalent to 1000 meters, add 10 per cent. and multiply by 36; the answer will be 39,600, which is 229.57 more than the exact number of inches equivalent to 1000 meters. Deduct from the answer (39,600) one-half per cent., (198) and the remainder will be 39,402, which is only 31.57 more than the exact number of inches equivalent to 1000 meters, (39,370 43).

130. To Convert Meters into Feet: ***Add 10 per cent. and multiply by 3.***

The answer will be too great by 19.13 feet for every 1000 meters, or about one half per cent. If one-half per cent. be deducted from that answer, the remainder will be too great by only about 2½ feet for every 1,000 meters, or one thirtieth inch for every meter. *Ex.:* To find the number, of feet equivalent to 1000 meters add 10 per cent. and multiply by 3; the answer will be 3,300.00, or 19.13 more than the exact number of feet equivalent to 1000 meters. Deduct from the answer (3,300.00) one-half per cent. (16.50), and the remainder will be 3,283.50, which is only about 2½ more than the exact number of feet equivalent to 1000 meters, (3,280.89 —).

131. To Convert Meters into Yards: ***Add 10 per cent.***

The answer will be too great by 19.13 feet for every 1000 meters, or a little over one half per cent. If one-half per cent. be deducted from that answer, the remainder will be too great by only about 32½ inches for every 1000 meters, or about one-thirtieth inch for every meter. *Ex.:* To find the number of yards equivalent to 1,000 meters, add 10 per cent.; the answer will be 1100 or 6.38 more than the exact number of yards equivalent to 1000 meters. Deduct from the answer (1100) one-half per cent. (5.50) and the remainder will be 1,094.50, which is only about 0.88 more than the exact number of yards equivalent to ,1000 metres, (1,093.61 +).

132. Prices. To convert approximately the price per meter into the price per yard, deduct 10 per cent.

133. The Centimeter. A familiar object lesson with which to connect the centimeter is the finger; the width of an average man's finger is about two centimeters. The diameter of an American five-cent coin is exactly two centimeters.

134. The Millimeter. Twenty-five (25) millimeters make about one inch.

METRIC SURFACE MEASURES.

The Centiare, or square meter.
The Are, or one hundred square meters.
The Hektare, or ten thousand square meters.

Equivalents in English Measures.

1 Square Meter is equal to 1·196011266 square yards.
1 Square Meter is equal to 10·7641014 square feet.
1 Square Meter is equal to 1,550·030915866 square inches.

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1 Are, or 100 square meters, is equal to 119.6011266 square yards.
1 Are is equal to 1,076.41014 square feet.
1 Are is equal to 155,003.0915866 square inches.

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1 Hektare is equal to 2·471 English acres.

MEASURES OF CAPACITY.

The Milliliter is the thousandth part of the Liter, or 0.001 Liter.
The Centiliter is the hundredth part of the Liter, or 0.01 Liter.
The Deciliter is the tenth part of the Liter, or 0·1 Liter.
The Liter.
The Dekaliter is 10 liters.
The Hektoliter is 100 liters.
The Kiloliter is 1,000 liters.

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10 Milliliters is 1 centiliter.
10 Centiliters is 1 deciliter.

10 Deciliters is 1 liter.
10 Liters is 1 dekaliter.
10 Dekaliters is 1 hektoliter.
11 Hektoliters is 1 kiloliter.

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135. **The Stere,** or Kiloliter, or Cubic Meter, is equal to 1,000 Liters.

Equivalents in English Measures.

1 Cubic Meter, or stère, is equal to 1·30798543 cubic yards.
1 Cubic Meter or stère,, is equal to 35·3156066 cubic feet.
1 Cubic Meter, or stère, is equal to 61,025.3868 cubic inches.

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1 Cubic Decimeter, or liter, is equal to 61·0253868 cubic inches.

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1 Cubic Centimeter, or milliliter, is equal to 0·0610254 cubic inch.

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1 Stère, or kiloliter, is equal to 264·179 wine gallons.
1 Stère, or kiloliter, is equal to 1,056·717 wine quarts.
1 Stère, or kiloliter, is equal to 2,113·433 wine pints.

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1 Stère, or kiloliter, is equal to 220·117 imperial gallons.
1 Stère, or kiloliter, is equal to 880·469 imperial quarts.
1 Stère, or kiloliter, is equal to 1760·938 imperial pints.

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1 Liter is equal to 0·264179 wine gallon.
1 Liter is equal to 1·056717 wine quarts.
1 Liter is equal to 2·113433 wine pints
1 Liter is equal to 33·814933 U. S. fluidounces.
1 Liter is equal to 270·519463 U. S. fluidrachms.
1 Liter is equal to 16,231·169 U. S. minims.

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1 Liter is equal to 0·220117 imperial gallon.

1 Liter is equal to 0·880469 imperial quart.
1 Liter is equal to 1·760938 imperial pints.
1 Liter is equal to 35.218753 imperial fluidounces.
1 Liter is equal to 281·75003 imperial fluidrachms.
1 Liter is equal to 16,905·002 imperial minims.

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136. The Liter is practically about 6 per cent. larger than the wine quart, being approximately equal to 34 U. S. fluid ounces.

One Liter of pure water at 4° C., and *in vacuo*, weighs theoretically 1 Kilogram, equal to a little over 32 troy ounces. At 22° C. and in air 1 Liter of water weighs 997.4 Gm., or 32.067 troy ounces.

137. To convert Liters into Wine Quarts. *Add 6 per cent.*

The answer will be too large by only about one-third of one per cent.

138. The Cubic-centimeter.—The Cubic-centimeter is also called a MILLILITER.

One U. S. fluid ounce is very nearly 30 Cubic-centimeters, and 1 Cubic-centimeter is very little over 16 U. S. minims.

Practically it is most convenient to consider 32 C.c. equal to 1 U. S. fluid ounce, and 1 C.c. equal to ¼ fluidrachm, and to 16 minims.

One cubic-centimeter of pure water at +4° C., (39° 2+)., weighs exactly 1 Gram; at 22° C. it weighs only 0.9974 Gm.

139. To Convert Cubic-centimeters into U. S. Minims. *Multiply by 16.*

The answer will be too small by 1.424 per cent. *Ex.*: To find the number of minims equal to 1,000 Cubic-centimeters multiply by 16; the answer is 16,000. But 1,000 Cubic-centimeters is exactly 16,231.169 U. S. minims, or 231.169 U. S. minims more than the answer, or 14.24 Cubic-centimeters for every liter, or 6.62 minims for every fluid ounce, or 1.42 per cent. too small.

If 1⅓ per cent. be added to the answer it will be 0.0544 per cent. too great, or only about ¼ minim for each fluid ounce.

140. To Convert Cubic-centimeters into U. S. Fluid Drachms. *Divide by 4.*

The answer is too small by 7.585 per cent. *Ex.*: To find the number of U. S. fluidrachms equivalent to 1,000 Cubic-centimeters, divide by 4; the answer is 250. But 250 fluidrachms is only 15,000 minims, whereas 1,000 Cubic-centimeters is exactly 16,231.169 minims. The answer, therefore, is too small by 1,231.169 minims or 75.85 Cubic-centimeters for every liter, or a little over 7½ per cent.

If 8 per cent. be added to the answer, it will then be too small by only 31 169 minims for every liter, or less than 1 minim for each fluid ounce.

141. To convert Cubic-centimeters into U. S. Fluid Ounces. *Divide by 32.*

The answer is too small by 7.585 per cent. If 8 per cent. be added to the answer it will then be too small by less than 1 minim for each fluid ounce.

142. To Convert Cubic-centimers into Wine Pints: *Add 10 per cent. and divide by 500.*

The answer will be too great by 0 09 pint for every 1,000 Cubic-centimeters, or about 4 per cent. If 5 per cent. be deducted from that answer the remainder will be too small by one-third fluid ounce for every 1,000 cubic-centimeters, or one-sixth of a minim for every Cubic-centimeter. *Ex.*: To find the number of wine pints equivalent to 1,000 Cubic-centimeters add 10 per cent., and divide the sum by 500; the answer will be 2.20, which is more by 0.09 than the exact number of wine pints equivalent to 1,000 Cubic centimeters Deduct from the answer (2.20) 5 per cent. (0.11) and the remainder will be 2.09, which is only 0.02 less than the exact number of wine pints equivalent to 1,000 Cubic-centimeters (2.11+).

143. To Convert Half-liters (or "metric pints" of 500 Cubic-centimeters each) into Wine Pints: *Add 10 per cent.*

The answer will be too great by 0.09 pint for every 1,000 Cubic-centimeters, or about 4 per cent. If 5 per cent. be deducted from the answer the remainder will be too small by one-third fluid ounce for every 1,000 Cubic-centimeters, or one-sixth of one minim for every Cubic centimeter. *Ex.*: To find the number of wine pints equivalent to two half-liters add 10 per cent.; the answer will be 2.2, which is more by 0.09 than the exact number of wine pints equivalent to 2 half-liters. Deduct from the answer (2.2) 5 per cent. (0.11), and the remainder will 2.09, which is only 0 02 less than the exact number of wine pints equivalent to 2 half-liters (2.11+).

144. **Prices.**—To compute the price per wine pint from the price per liter: *Divide by 2.11.*

The answer will be too large by only about one-sixth per cent.

METRIC MEASURES OF WEIGHT.

The Milligram is the thousandth part of the Gram, or 0.001 Gram.
The Centigram is the hundredth part of the Gram, or 0.01 Gram.
The Decigram is the tenth part of the Gram, or 0.1 Gram.

The Gram.

The Dekagram is ten Grams.
The Hektogram is one hundred Grams.
The Kilogram is one thousand Grams.

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10 Milligrams is one centigram.
10 Centigrams is one decigram.
10 Decigrams is one Gram.
10 Grams is one dekagram.
10 Dekagrams is one hektogram.
10 Hektograms is one kilogram.

Equivalents of Metric Weight in Avoirdupois.

1 Gram is equal to 0·002204621 avoirdupois pound.
1 Gram is equal to 0·03527394 avoirdupois ounce.
1 Gram is equal to 0·56438304 avoirdupois drachm.
1 Gram is equal to 15·43234874 avoirdupois grains.

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1 Decigram is equal to 0·0002204621 avoirdupois pound.
1 Decigram is equal to 0·003527394 avoirdupois ounce.
1 Decigram is equal to 0·056438304 avoirdupois drachm.
1 Decigram is equal to 1·543234874 avoirdupois grains.

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1 Centigram is equal to 0·00002204621 avoirdupois pound.
1 Centigram is equal to 0.0003527394 avoirdupois ounce.
1 Centigram is equal to 0·0056438304 avoirdupois drachm.
1 Centigram is equal to 0.1543234874 avoirdupois grain.

1 Milligram. is equal to 0·000002204621 **avoirdupois pound.**
1 Milligram is equal to 0·00003527394 **avoirdupois ounce.**
1 Milligram is equal to 0·0005643⁸304 **avoirdupois drachm.**
1 Milligram is equal to 0·01543234874 **avoirdupois grain.**

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1 Kilogram is equal to 2·204621 **avoirdupois pounds.**
1 Kilogram is equal to 35·27394 avoirdupois ounces.
1 Kilogram is equal to 564·38304 avoirdupois drachms.
1 Kilogram is equal to 15,432·34874 avoirdupois grains.

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1 Hektogram is equal to 0·2204621 avoirdupois pounds.
1 Hektogram is equal to 3·527394 avoirdupois ounces.
1 Hektogram is equal to 56·438304 avoirdupois drachms.
1 Hektogram is equal to 1,543·234874 avoirdupois grains.

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1 Dekagram is equal to 0·02204621 avoirdupois pound.
1 Dekagram is equal to 0·3527394 avoirdupois ounce.
1 Dekagram is equal to 5·6438304 avoirdupois drachms.
1 Dekagram is equal to 154·3234874 avoirdupois grains.

Equivalents of Metric Weight in U. S. Apothecaries' Weight.

1 Gram is equal to 0·032150727 ounce (Troy).
1 Gram is equal to 0·257205812 apothecaries' drachm.
1 Gram is equal to 0·771617437 scruple.
1 Gram is equal to 15·43234874 grains (Troy).

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1 Decigram is equal to 0·0032150727 ounce (Troy).
1 Decigram is equal to 0·0257205812 apothecaries' drachm.
1 Decigram is equal to 0·0771617437 scruple,
1 Decigram is equal to 1·543234874 grains (Troy)

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1 Centigram is equal to 0·00032150727 ounce (Troy).
1 Centigram is equal to 0·00257205812 apothecaries' drachm.
1 Centigram is equal to 0·00771617437 scruple.
1 Centigram is equal to 0·1543234874 grain (Troy).

1 Milligram is equal to 0·000032150727 ounce (Troy).
1 Milligram is equal to 0·000257205812 apothecaries' drachm.
1 Milligram is equal to 0·000771617437 scruple.
1 Milligram is equal to 0·01543234874 grain (Troy).

1 Kilogram is equal to 32·150727 ounces, troy.
1 Kilogram is equal to 257·205812 apothecaries' drachms.
1 Kilogram is equal to 771·617437 scruples.
1 Kilogram is equal is equal to 15,432·348740 grains (Troy).

1 Hektogram is equal to 3·2150727 ounces (Troy).
1 Hektogram is equal to 25·7205812 apothecaries' drachms.
1 Hektogram is equal to 77·1617437 scruples.
1 Hektogram is equal to 1,543·234874 grains (Troy).

1 Dekagram is equal to 0·32150727 ounce (Troy).
1 Dekagram is equal to 2·57205812 apothecaries' drachms.
1 Dekagram is equal to 7·71617437 scruples.
1 Dekagram is equal to 154·3234874 grains (Troy).

145. The Gram.—It is most convenient, all things considered, to regard the Gram as practically equivalent to 16 grains. At the same time it should be treated as also equal to ¼ drachm, and $\frac{1}{32}$ of a troy ounce.

One Gram of pure water at +4°C. (39°.2F.) measures 1 Cubic-centimeter; at 22° C. it measures 1.0026 C. c.

146. To Convert Grams into Avoirdupois Ounces. *Divide by 30, and to the quotient add 6 per cent.*

The answers will be too large by less than 0.006 per cent., or 6 grams in 100 kilograms.

147. To Convert Grams into Avoirdupois Pounds: *Add 10 per cent. and divide by 500.*

The answer will be too small by 32.35 grains in every 1,000 Grams, or about one-fourth per cent. If one-fourth per cent. be added to that answer the result will be too great by only 6.3 grains for every 1,000 Grams, or about one one-hundred-and-fiftieth of a grain for every Gram. *Ex.:* To find

the number of avoirdupois pounds equivalent to 1,000 Grams, add 10 per cent. and then divide the sum by 500; the answer will be 2.2, which is 0.0046 less than the exact number of avoirdupois pounds equivalent to 1,000 Grams. Add to the answer (2 2) one-fourth per cent. (0.0055) and the sum will be 2.2055, which is only 0 0009 more than the exact number of avoirdupois pounds equivalent to 1,000 Grams (2.20462+.)

148. To Convert Grams into Grains: *Multiply by 16.*

The answer will be too large by 3.68 per cent. *Ex.:* To find the number of grains equivalent to 1,000 Grams, multiply by 16; the answer will be 16,000 But 1,000 Grams is equivalent to exactly 15,432 34874 grains, or 567.65126 grains less than the answer obtained. The answer is in other words too large by 568 grains, or 3.68 Grams, in every 1,000 Grams, or 3.68 per cent.

If greater accuracy is desired, use the following rule: Add 50 per cent., then multiply by 10, and to the product add 3 per cent. This will give an answer which deviates from exactness by only 1.14 grains for every 1,000 Grams, or about one-tenth of 1 per cent. (excess).

149. To Convert Grams into Apothecaries' Drachms. *Divide by 4.*

The answers will be as near correct as those obtained by the following,

150. To Convert Grams into Troy or U. S. Apothecaries' Ounces. *Divide by 32.*

The answers are too large by 0.47 per cent. *Ex.:* To find the number of troy ounces equivalent to 32,000 Grams, divide by 32; the answer is 1,000. But 1,000 troy ounces is exactly 32,150.727 Grams, or 150.727 Grams more than the true answer. This amounts to a difference of 4.71 Grams for every 1,000 Grams or an excess of less than one-half per cent.

151. The Decigram.—This unit is nearer our troy grain than any other, being but very little over 1½ grain. It is scarcely used, however.

152. To Convert Decigrams into Grains. *Add 60 per cent.*

The answer is too large by 3.68 per cent.

If greater accuracy is desired, use the following rule: Add 50 per cent. and then add 3 per cent. to the sum. The answer is too large by only about one-tenth of one per cent.

153. The Centigram.—The value of this unit may be roughly remembered by the fact that our troy grain is about

equal to 6 "cents," the term "cent" being a convenient abbreviation for centigram.

The centigram is a convenient weight unit in medicine. But there is no corresponding unit of fluid measure.

154. To Convert Centigrams into Troy Grains. *Add 60 per cent., and divide the sum by 10.*

The answer will be too large by 3.68 per cent.

The following rule gives more accurate results: Add 50 per cent., then divide the sum by 10, and to the quotient add 3 per cent. The answer will be too great by only about one-tenth of one per cent.

155. The Milligram.—This is the smallest metric weight unit, and it is equal to about $\frac{1}{64}$ troy grain—a convenient unit for stating doses of the most potent medicines.

There is no corresponding unit of fluid measure.

156. To Convert Milligrams into Grains.—*Add 60 per cent., and divide the sum by 100.*

The answer is too large by 3.68 per cent.

157. The Kilogram.—Equal to 10 per cent. more than two avoirdupois pounds.

One theoretical kilogram of pure water at + 4° C. (39.°2F.), weighed *in vacuo*, measures 1 Liter; at 22° C. it measures 1,002.12 C. c.

An actual kilo of water, weighed *in vacuo*, measures 999.415 C. c., at + 4.° C.; but 1 kilo water at 22° C., weighed in air, measures 1,002.6 C. c.

158. To Convert Kilograms into Avoirdupois Pounds. *Multiply by 2, and to the product add 10 per cent.*

The answer will be too small by about one-fourth of one per cent.

159. To Convert Half-Kilograms (or "Metric Pounds" of 500 Grams each) into Avoirdupois Pounds. *Add 10 per cent.*

The answer will be too small by 32.35 grains for every 1,000 Grams, or about one-fourth of one per cent. If one-fourth per cent. be added to the answer the result will be too great by only 6.3 grains for every 1,000 Grams, or about one one-hundred-and fiftieth part of a grain for each Gram. *Ex.:* To find the number of avoirdupois pounds equivalent to 2

half-kilograms, add ten per cent.; the answer will be 2.2 avoirdupois pounds, which is 0.0046 less than the exact number of avoirdupois pounds contained in 2 half-kilograms or 1 kilogram. Add to the number (2.2) one-fourth of one per cent. (0.0055) and the sum will be 2.2055, which is only 0.0009 more than the exact number of avoirdupois pounds equivalent to 2 half-kilograms (2.20462+).

160. **Prices.**—To compute the price per avoirdupois pound from the price per kilogram: *Divide by 2.2.*

The answer will be too large by only about one-fifth per cent.

APPROXIMATE EQUIVALENTS OF METRIC WEIGHTS AND MEASURES IN U. S. APOTHECARIES' WEIGHTS AND FLUID MEASURES.

161. These equivalents are obtained by assuming that 16 grains is equal to 1 Gram and 16 minims equal to 1 Cubic-centimeter (or fluigram), and that 1 troy ounce is equal to 32 Grams, and 1 U. S. fluid ounce equal to 32 Cubic-centimeters (or fluigrams). They are, therefore, incorrect to the extent of from 2 to 8 per cent. This difference the author regards as material for prescribing and dispensing.

162. Doses are empirical. They depend upon the values of the units of weights and measures to a greater extent than ...er cent., for no physician would be able to appreciate any ...rence in effect as between 1 grain and $1\frac{1}{10}$ grain, or between ...ce and $\frac{9}{10}$ ounce. No matter what the remedy may be ... the physician prescribes, it would be quite absurd to say ... he could determine in advance within such narrow ... as 3, or 5, or 8 or 10, or even 20 per cent., the most ap... ...ate quantity to be administered in each dose in any par... ...ase. He can at most guess approximately correctly, ...ccordingly, and by closely observing the effects he is ...ble to increase or decrease the frequency or size of ...o continue the medicine a longer or shorter period, ...y require, to produce the desired results.

The customary "teaspoonfuls" and "tablespoonfuls" vary from 25 to 100 per cent., and, finally, the quality of drugs and medicines varies as much or more, one lot being good, another only half as active, and still another, perhaps, entirely inert. But, even with the most accurate weights and measures, the utmost care possible in preparing, prescribing and dispensing the very best drugs or chemicals, and patients of perfect sameness in all respects, it will be conceded that absolute exactness is unattainable as to posology, simply because no one can know what an exact dose is.

163. These statements, however, should not be misconstrued to indicate that care and precision are of little value in medicine and pharmacy, On the contrary, it is the highest duty of every physician and every pharmacist to use all practicable means to insure the greatest attainable degree of uniformity in all that affects the quality and strength of any medicinal preparations.

164. In the official report made by the author to the Surgeon-General of the U. S. Marine-Hospital Service in 1877, which led to the order of April 27, 1878, making the use of the Metric System of weights and measures obligatory upon the medical officers of that service, the following passage occurs:— "The important advantage of a simple relation between the units of weight and the units of measure is acknowledged, and is one of the strong arguments in favor of the metric system, the weight unit or "Gram" being the weight of one Cubic-centimeter of distilled water of maximum density under the pressure of one atmosphere. The minim and the grain, however, have no simple relation to each other ; but as the difference between the weight of one minim of distilled water of maximum density under the pressure of one atmosphere, and the weight of a troy grain, is comparatively small, it has been ignored entirely in preparing the rules for the conversion of apothecaries' measure into metric measure, and hence the arithmetical processes in the rules for converting old measures

into new are respectively identical with the processes given in the rules for converting weights. For this purpose one minim is considered as weighing one grain, one fluid drachm as weighing one drachm, and one fluid ounce as weighing one ounce."

The only differences between the equivalents then given and those now proposed in this book arise from the fact that it is here assumed that 1 Gram and 16 grains are equal quantities, and that 1 Cubic-centimeter is equal to 16 minims, whereas the old were based upon the assumption that the Gram is equal to 15 grains, and 1 Cubic-centimeter equal to 15 minims.

The real equivalents are:

1 Gram = 15.432 grains.
1 Cubic-centimeter = 16.231 minims.

165 In actual practice these are the most convenient equivalents to use, and the author recommends them above any other. They not only connect our weights and measures in a simple manner with the Metric System, but they also simplify the relations of weight to volume as well as the proportional strength of liquid preparations, and are sufficiently accurate (see par. 64).

Milligrams (or Mills) in Grains.

1 Milligram (or Mill) = $\frac{1}{60}$ grain.		3 Milligrams (or Mills) = $\frac{1}{20}$ grain.	
" = $\frac{1}{300}$ "		4 " = $\frac{1}{15}$ "	
" = $\frac{1}{200}$ "		5 " = $\frac{1}{12}$ "	
" = $\frac{1}{150}$ "		6 " = $\frac{1}{10}$ "	
" = $\frac{1}{120}$ "		7 " = $\frac{1}{9}$ "	
" = $\frac{1}{100}$ "		8 " = $\frac{1}{8}$ "	
" = $\frac{1}{90}$ "		9 " = $\frac{1}{7}$ "	
" = $\frac{1}{80}$ "		10 " = $\frac{1}{6}$ "	
" = $\frac{1}{70}$ "		12 " = $\frac{1}{5}$ "	
" = $\frac{1}{60}$ "		16 " = $\frac{1}{4}$ "	
" = $\frac{1}{50}$ "		20 " = $\frac{1}{3}$ "	
" = $\frac{1}{40}$ "		30 " = $\frac{1}{2}$ "	
" = $\frac{1}{30}$ "		60 " = 1 "	

Centigrams (or Cents) in Grains.

1 Centigram (or Cent)	=	$\frac{1}{6}$	grain.
2 " "	=	$\frac{1}{3}$	"
3 " "	=	$\frac{1}{2}$	"
4 " "	=	$\frac{2}{3}$	"
5 " "	=	$\frac{5}{6}$	"
6 " "	=	1	"
7 " "	=	$1\frac{1}{6}$	"
8 " "	=	$1\frac{1}{3}$	"
9 Centigrams (or Cents)	=	$1\frac{1}{2}$	grains.
10 " "	=	$1\frac{2}{3}$	"
12 " "	=	2	"
18 " "	=	3	"
25 " "	=	4	"
50 " "	=	8	"
75 " "	=	12	"
100 " "	=	16	"

Grams in Grains.

0.001 Gram	=	$\frac{1}{60}$	grain.
0.010 " "	=	$\frac{1}{6}$	"
0.100 " "	=	$1\frac{2}{3}$	"
0.250 " "	=	4	"
0.500 " "	=	8	"
0.750 " "	=	12	"
1 " "	=	16	"
1.50 Grams	=	24	"
2 " "	=	32	"
3 " "	=	48	"
4 " "	=	64	"
5 " "	=	80	"
6 " "	=	96	"
7 " "	=	112	"
8 " "	=	128	"
9 " "	=	144	"
10 " "	=	160	"
11 " "	=	176	"
12 " "	=	192	"
13 " "	=	208	"
14 " "	=	224	"
15 " "	=	240	"
16 " "	=	256	"
17 " "	=	272	"
18 " "	=	288	"
19 Grams	=	304	grains.
20 " "	=	320	"
21 " "	=	336	"
22 " "	=	352	"
23 " "	=	368	"
24 " "	=	384	"
25 " "	=	400	"
26 " "	=	416	"
27 " "	=	432	"
28 " "	=	468	"
29 " "	=	464	"
30 " "	=	480	"
31 " "	=	496	"
32 " "	=	512	"
33 " "	=	528	"
34 " "	=	544	"
35 " "	=	560	"
36 " "	=	576	"
37 " "	=	592	"
38 " "	=	608	"
39 " "	=	624	"
40 " "	=	640	"
50 " "	=	800	"
100 " "	=	1,600	"

Grams in U. S. Apothecaries' Drachms.

1 Gram =	¼	Drachm.	
2 Grams	½	"	
3 "	¾	"	
4 "	1	"	
5 "	1¼	"	
6 "	1½	"	
7 "	1¾	"	
8 "	2	"	
9 "	2¼	"	
10 "	2½	"	
11 "	2¾	"	
12 "	3	"	
13 "	3¼	"	
14 "	3½	"	
15 "	3¾	"	
16 "	4	"	
"	4¼	"	
"	4½	"	
"	4¾	"	
"	5	"	
"	5¼	"	
"	5½	"	
"	5¾	"	

24 Grams =	6	Drachms.	
25 "	6¼	"	
26 "	6½	"	
27 "	6¾	"	
28 "	7	"	
29 "	7¼	"	
30 "	7½	"	
31 "	7¾	"	
32 "	8	"	
33 "	8¼	"	
34 "	8½	"	
35 "	8¾	"	
36 "	9	"	
37 "	9¼	"	
38 "	9½	"	
39 "	9¾	"	
40 "	10	"	
50 "	12½	"	
60 "	15	"	
70 "	17½	"	
80 "	20	"	
90 "	21½	"	
100 "	25	"	

Grams in Troy or U. S. Apothecaries' Ounces.

am =	1/32	troy ounce.	
ms "	1/16	"	
"	1/8	"	
"	1/4	"	
"	3/8	"	
	1/2	"	
	5/8	"	
	3/4	"	
	1	"	
		"	
		"	
		"	

64 Grams =	2	Troy ounces,	
96 "	3	"	
128 "	4	"	
160 "	5	"	
192 "	6	"	
224 "	7	"	
256 "	8	"	
288 "	9	"	
320 "	10	"	
352 "	11	"	
384 "	12	"	

416	Grams	=	13	troy	ounces.		
448	"	"	14	"			
480	"	"	15	"			
512	"	"	16	"			
544	"	"	17	"			
576	"	"	18	"			

608	Grams	=	19	Troy	ounces.		
640	"	"	20	"			
960	"	"	30	"			
1280	"	"	40	"			
1600	"	"	50	"			

Cubic-centimeters (or Fluigrams) in U. S. Minims.

0.005	C.c.	=	$\frac{1}{12}$	U. S.	Minims.		
0.006	"		$\frac{1}{10}$				
0.007	"		$\frac{1}{9}$				
0.008	"		$\frac{1}{8}$				
0.009	"		$\frac{1}{7}$				
0.010	"		$\frac{1}{6}$				
0.012	"		$\frac{1}{5}$				
0.016	"		$\frac{1}{4}$				
0.02	"		$\frac{1}{3}$				
0.03	"		$\frac{1}{2}$				
0.04	"		$\frac{2}{3}$				
0.05	"		$\frac{5}{6}$				
0.06	"		1				
0.09	"		$1\frac{1}{2}$				
0.12	"		2				
0.18	"		3				

0.25	C.c.	=	4	U. S.	Minims.		
0.30	"		5				
0.50	"		8				
0.75	"		12				
1	"		16				
$1\frac{1}{2}$	"		24				
2	"		32				
3	"		48				
4	"		64				
5	"		80				
6	"		96				
7	"		112				
8	"		128				
9	"		144				
10	"		160				

Cubic-centimeters (or Fluigrams) in U. S. Apothecaries' Fluidrachms.

1	C.c.	=	$\frac{1}{4}$	U. S.	Fluidrachm.		
2	"	"	$\frac{1}{2}$	"			
3	"	"	$\frac{3}{4}$	"			
4	"	"	1	"			
5	"	"	$1\frac{1}{4}$	"			
6	"	"	$1\frac{1}{2}$	"			
7	"	"	$1\frac{3}{4}$	"			
8	"	"	2	"			

9	C.c.	=	$2\frac{1}{4}$	U. S.	Fluidrachms.		
10	"	"	$2\frac{1}{2}$	"	"		
11	"	"	$2\frac{3}{4}$	"	"		
12	"	"	3	"	"		
13	"	"	$3\frac{1}{4}$	"	"		
14	"	"	$3\frac{1}{2}$	"	"		
15	"	"	$3\frac{3}{4}$	"	"		
16	"	"	4	"	"		

20	C.c.	= 5	U. S. Fluidrachms.	32	C.c.	= 8	U. S. Fluidrachm.
24	"	" 6	" "	48	"	" 12	"
28	"	" 7	" "	64	"	" 16	"

Cubic-centimeters (or Fluigrams) in U. S. Apothecaries' Fluid Ounces.

1	C.c.	=	$\frac{1}{31}$ U. S. Fluidounce.	120	C.c.	=	$3\frac{3}{4}$ U. S. Fluidounces.
2	"	"	$\frac{1}{16}$ "	128	"	"	4 "
3	"	"	$\frac{3}{32}$ "	136	"	"	$4\frac{1}{4}$ "
4	"	"	$\frac{1}{8}$ "	144	"	"	$4\frac{1}{2}$ "
6	"	"	$\frac{3}{16}$ "	152	"	"	$4\frac{3}{4}$ "
8	"	"	$\frac{1}{4}$ "	160	"	"	5 "
10	"	"	$\frac{5}{16}$ "	192	"	"	6 "
12	"	"	$\frac{3}{8}$ "	224	"	"	7 "
16	"	"	$\frac{1}{2}$ "	256	"	"	8 "
20	"	"	$\frac{5}{8}$ "	288	"	"	9 "
24	"	"	$\frac{3}{4}$ "	320	"	"	10 "
32	"	"	1 "	352	"	"	11 "
40	"	"	$1\frac{1}{4}$ "	384	"	"	12 "
48	"	"	$1\frac{1}{2}$ "	416	"	"	13 "
56	"	"	$1\frac{3}{4}$ "	448	"	"	14 "
64	"	"	2 "	480	"	"	15 "
72	"	"	$2\frac{1}{4}$ "	512	"	"	16 "
80	"	"	$2\frac{1}{2}$ "	640	"	"	20 "
88	"	"	$2\frac{3}{4}$ "	960	"	"	30 "
96	"	"	3 "	1280	"	"	40 "
104	"	"	$3\frac{1}{4}$ "	1600	"	"	50 "
112	"	"	$3\frac{1}{2}$ "	3200	"	"	100 "

ENGLISH AND AMERICAN WEIGHTS AND MEASURES.

166. Old English Weights and Measures.—We have seen (23 and 28) that great diversity has existed in English weights and measures. It is here proposed to describe only those now in general use and those referred to in the pharmacopœias of this country and England.

167. Present English Weights and Measures.—The English weights and measures were reconstructed by a law passed in 1824, which took effect January 1st, 1826. Prior to that time there had been great confusion. Thus no less than three different gallons were in use—the wine gallon of 231 cubic inches, the corn gallon of 268.8 cubic inches, and the ale gallon of 282 cubic inches. These were all superseded at that date by the new Imperial gallon of 277.240 cubic inches. (See foot note on p. 87.)

The Troy Pound, although continued as the lawful standard, was supplemented in law as it had already been supplanted in actual use by the avoirdupois pound, the value of which was declared to be $\frac{7000}{5760}$ of the standard Troy Pound.

168. American Weights and Measures.—In America, however, the weights and measures originally introduced from England have not been changed as there. The wine gallon is still our gallon, the Imperial gallon never having been introduced into the United States. The avoirdupois pound is used for all commercial purposes, but the old Troy weight is still used by jewellers; the apothecaries' weights based on the Troy Pound are also still in use, and the only reference made in the United States Statutes at Large to any standard for weights is

in Sec. 3548 which provides that "For the purpose of securing a due conformity in weight of the coins of the United States, the brass troy-pound weight procured by the minister of the United States at London in the year 1827, for the use of the mint and now in the custody of the mint at Philadelphia, shall be the standard troy pound of the Mint of the United States, conformably to which the coinage thereof shall be regulated." This law was enacted in 1873.

169. **No Legal Standards for the United States.** — There is no law of the United States to fix the value of any one of the units of weight or measure used by the people of this country.

The copy of the English Troy Pound, obtained in 1827, which was adopted and declared by law Feb. 12, 1873, to be the "standard troy pound of the mint of the United States, to which the coinage thereof shall be regulated," is the only actual standard or prototype we have. But there is nothing in the statutes defining the value of that standard weight with relation to any unalterable natural standard. If it should be lost destroyed, or injured, another true copy of the British standard Troy Pound would doubtless be obtained to take its place; but this new copy would not be another "standard troy pound of the mint of the United States" until specially declared to be so by act of Congress.

170. The weights and the measures of length and of capacity in actual use in the United States are probably as accurate and uniform as are those used in any other country; but the fact remains that they are dependent upon foreign original standards for such uniformity.

The wine gallon used in the United States is 231 cubic inches; but as this gallon was abolished in England sixty years ago, and is now nowhere used outside of this country, there is no law at present in force fixing its value. (169).

171. **Metric System Legalized.**—By act of July 28, 1866, it was enacted that "it shall be lawful throughout the

United States of America to employ the weights and measures of the metric system ; and no contract or dealing, or pleading in any court shall be deemed invalid or liable to objection because the weights or measures expressed or referred to therein are weights or measures of the metric system." (Sec. 3569, Rev. Stat., U. S.)

172. **Legally Established Equivalents.**—Tables of equivalents showing the relation of metric weights and measures to those in common use were also made part of the law of 1866, and section 3570 of the Revised Statutes of the United States provides that these tables "shall be recognized in the construction of contracts, and in all legal proceedings, as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the Metric System; and the tables may lawfully be used for computing, determining and expressing in customary weights and measures the weights and measures of the Metric System."

These legally established equivalents are as follows :

1 Kilometer = 0.62137 miles, or 3,280 feet and 10 inches.
1 Meter = 39.37 inches.
1 Hektare = 2.471 acres.
1 Are = 119.6 square yards.
1 Centare = 1550 square inches.
1 Cubic Meter = 1.308 cubic yards, or 264.17 wine gallons.
1 Hektoliter = 2 bushels and 3.35 pecks, or 26.417 gallons.
1 Liter = 0.908 quarts dry measure, or 1.0567 quarts wine measure.
1 Deciliter = 6.1022 cubic inches, or 0.845 gills.
1 Centiliter = 0.6102 cubic inch, or 0.338 fluid ounce
1 Cubic-centimeter = 0.061 cubic inch, or 0.27 fluid drams.
1 Kilogram = 2.2046 pounds avoirdupois weight.
1 Hektogram = 3.5274 avoirdupois ounces.
1 Dekagram = 0.3527 avoirdupois ounces
1 Gram = 15.432 grains.

173. **Inaccuracy of above Equivalents.**—It will be observed that these legally established equivalents are not con-

sistent with each other, the decimals not being carried out to the same extent in all cases; Thus if 1 hektogram is equal to 3.5274 avoirdupois ounces, the dekagram must be 0.35274 and not 0.3527 avoirdupois ounces. They are sufficiently accurate for the purposes for which they are intended, but would be inadequate for the purpose of establishing proper standards.

174. **Metric Postal Balances.**—Under sec. 3880 of the Revised Statutes, the Postmaster-General is required to furnish to the post offices of the United States exchanging mails with foreign countries, *and to such other offices as he may deem expedient*, postal balances denominated in Grams of the Metric System, "fifteen Grams of which shall be the equivalent, for postal purposes, of one half-ounce avoirdupois, and so on in progression."

175. **Standard Weights and Measures furnished by the U. S. Government.**—By joint resolution of Congress, approved July 27, 1866, the Secretary of the Treasury is required to furnish to each state of the United States "one set of the standard weights and measures of the Metric System, for the use of the States, respectively."

These standard weights and measures are the only ones provided for by law to be furnished for the use of the people of the United States.

176. In view of the foregoing, we may well ask what are the weights and measures of the United States?

Whatever may be the right answer to this question, it seems rational to refer the values of all our units of weights and measures to the metric standards until specific legislation shall have been had on this subject; not only because these standards are unalterable and universally understood, but because so far as we have any laws on the subject they are decidedly more specific with regard to the Metric system than with reference to other weights and measures.

177. **Relations of Metric to English Standards.**—All the equivalents given in this book are based upon the de-

terminations made for the British Government by Captain Clarke and Professor Miller.

These determinations are now generally accepted as the most reliable experimental determinations yet made.

The length of the Meter, according to Captain A. R. Clarke, of the British Ordinance Survey, is equal to 39.370432 English inches.

The weight of the Gram, according to Professor W. H. Miller, of London, as adopted by the Standards Departmentof the British Government, is equal to 15.43234874 English troy grains.

English Long Measures.

178. The natural standard for English linear measure is the length of the seconds' pendulum at Greenwich or London, which is declared by law to contain 39.1393 inches.

179. The actual standard or prototype is a brass rod, in which are inserted two gold pins dressed off down to the surface of the flat bar or rod ; so that the transverse section is all that is visible of each gold pin. In the center of each gold pin there is a small dot, and the distance between the centers of these two dots, measured at 62° F., is the standard yard. That distance comprehends 36 inches of such length as to be contained 39.1393 times in the length of the seconds' pendulum in the latitude of London. (Law of 1823.)

180. In reality, the exact value of the English inch may also, and with equal accuracy and convenience, be referred to the meter. The inch is contained in the Meter 39.370432 times (177).

Table of Long Measure.

1 League = 3 miles, or 5,280 yards.
1 Mile = 8 furlongs, or 1760 yards.
1 Furlong = 40 poles or rods.
1 Pole or Rod = 5½ yards.
1 Yard = 3 feet or 36 inch
1 Foot = 12 inches.

181. In addition to the above units the following are still occasionally used: the palm = 3 inches; the hand = 4 inches; the span = 9 inches; and the fathom = 6 feet.

Exact Equivalents in Metric Terms.

1 League = 4,827.9886 meters.
1 Mile = 1,609 3295 meters.
1 Furlong = 201.16619 meters.
1 Pole or Rod = 5.0291548 meters.
1 Yard = 0.91439178 meter.
1 Foot = 30.479726 centimeters
1 Inch = 25.39977 millimeters.

182. Geographical Mile.—One "degree" is divided into 60 geographical miles; 60 of these miles equal 69⅛ English miles, or 11,120.74 Meters.

183. To Convert Yards into Meters: *Deduct 10 per cent.*

The answer will be too small by 15.75 yards for every 1,000 yards, or a little over 1½ per cent. If 1½ per cent. be added to that answer, the sum will be too small by only about 35½ inches for every 1,000 yards, or one-thirtieth inch for every yard. *Ex.:* To find the number of meters equivalent to 1,000 yards, deduct 100; the remainder, 900, lacks 14.39 of being the exact number of meters equivalent to 1,000 yards. Add to the answer (900) 1½ per cent. (13.50) and the sum will be 913.50, which is only 0.9 less than the exact number of meters equivalent to 1,000 yards, (914.39 +.)

184. Prices. To find the price per meter from the price per yard: *Add 10 per cent.*

The answer will be too small by about three-fifths of one per cent. or, sixty-three cents for every hundred dollars.

185. To Convert Feet into Meters: *Multiply by 3 and de by 10.*

he answer will be too small by 15.75 feet for every 1,000 feet, or a er 1½ per cent. If 1½ per cent. be added to that answer, the sum too small by only about one foot for every 1,000 feet, or about one- inch for every foot. *Ex.:* To find the number of meters equiva- ,000 feet, multiply by 3 and divide the product by 10; the answer

will be 300, or 4.8 less than the exact number of meters equivalent to 1,000 feet. Add to the answer (300) 1½ per cent. (4.50) and the sum will be 304.50, which is only about 0.3 less than the exact number of meters equivalent to 1,000 feet, (304 80—.)

186. The Inch is about 2½ centimeters, or 25 millimeters.

187. To Convert Inches into Meters: *Divide by 40.*

The answer will be too small by 15.75 inches for every 1,000 inches, or about 1½ per cent. If 1½ per cent. be added to that answer, the sum will be too small by about 1 inch for every 1,000 inches, or about $\frac{1}{1000}$ inch for every inch. *Ex.:* To find the number of meters equivalent to 1,000 inches, divide by 40; the answer will be 25, which is 0.4 less than the exact number of meters equivalent to 1,000 inches. Add to the answer (25) 1½ per cent., (375,) and the sum wlll be 25.375, which is only about 0,025 less than the exact number of meters equivalent to 1,000 inches, (25.40—.)

188. To Convert Inches into Centimeters: *Multiply by 2.5.*

The deviation from exactness is the same as in the preceding rule.

189. To Convert Inches into Millimeters: *Multiply by 25.*

The deviation from exactness is the same as in the two rules just preceding.

Superficial Measure.

1 Square Mile = 64 acres.
1 Acre = 4 roods, or 4,840 square yards, or 43,560 square feet.
1 Rood = 40 square poles.
1 Square Pole = 30¼ square yards.
1 Square Yard = 9 square feet
1 Square Foot = 144 square inches.

190. Land Measure. To measure land the "chain" is used; the chain is equal to 4 poles or 22 yards, and is divided into 100 "links." Ten square chains (ten chains in length and one in breadth) make one acre, which is equal to 160 square "perches" (or square poles), or 4840 square yards.

Exact equivalents in Metric Terms

1 Square yard=0.8361 square meters.
1 Square Foot=9.290 square decimeters.
1 Square Inch=6.452 square centimeters.

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1 Acre=0.4047 hektares, or 40.47 square meters.
1 Square Mile=259 hectares.

CUBIC MEASURES.

1 Cubic Yard=27 cubic feet.
1 Cubic Foot=1,728 cubic inches.

Metric Equivalents.

1 Cubic Yard=0.7646 cubic meters.
1 Cubic Foot=28.32 cubic decimeters
1 Cubic Inch=16.36 cubic centimeters.

OLD DRY OR WINCHESTER MEASURE

191. This is the dry measure of England prior to 1826, and still in use in the United States.

1 Bushel=4 peck, or 32 dry quarts.
1 Dry Peck=2 dry gallons, or 8 dry quarts.
1 Dry Gallon=4 dry quarts.
1 Dry Quart=2 dry pints.

Equivalents in Cubic Inches.

1 Bushel=2150.42 cubic inches.
1 Peck=537.6 cubic inches

1 Dry Gallon=268.8 cubic inches.
1 Dry Quart=67.2 cubic inches.
1 Dry Pint=33.6 cubic inches.

Equivalents in Metric Terms.

I Bushel=35.24 liters.
1 Peck=8.81 liters.
1 Dry Gallon=4.40 liters.
1 Dry Quart=1.10 liters.
1 Dry Pint=0.55 liters.

192. The Winchester bushel and peck (used in the United States) differ from the Imperial bushel and peck (used in Great Britain), as follows:

	Cubic inches.	
	Winchester Measure.	*Imperial Measure.*
1 Bushel=	2150.4	2218.2.
1 Peck =	537.6	554.5.

The Winchester gallon, quart and pint (the dry measures used in the United States) differ from the wine gallon, quart and pint (the liquid measures used in the United States), and from the Imperial gallon, quart and pint (used in England), as follows:

	Cubic Inches.	
Winchester Measure.	*Wine Measure.*	*Imperial Measure.*
1 Gallon = 268.8	231.0	277.240
1 Quart = 67.2	57.75	69 310
1 Pint = 33.6	28.875	34.655

Wine Measure, or U. S. Liquid Measure.

193. Wine measure was used in England prior to 1826. It is the only liquid measure still in common use in the United States.

194. **The Wine Gallon** should be exactly 231 cubic inches, but its value is not fixed by law.

It is divided into 4 quarts, and into 8 pints.

195. **The Wine Pint** is divided into 16 fluid ounces. Six pints of pure water weighs almost exactly 100 avoirdupois ounces.

196. **The U. S. Fluidounce** is about 4 per cent. larger than the Imperial fluidounce. It is divided into 8 fluidrachms and into 480 minims.

197, **One U. S. Minim** of pure water at 22.° C. weighs only 0.948311 grain.

198. **The term Wine Measure** applies to the wine gallon, wine quart and wine pint.

199. **U. S. Apothecaries' Fluid Measures** are the wine pint, and its subdivisions, the U. S. fluidounce, U. S. fluidrachm, and U. S. Minim, which are the measures commonly used in medicine and pharmacy in the United States.

200. **The Symbols of U. S. Apothecaries' Fluid Measure.**—The signs used in writing and typography to designate the units of apothecaries' fluid measure are: ♏, denoting minim or minims; f ʒ denoting fluidrachm or fluidrachms; f ℥, denoting fluidounce or fluidounces. The quantities to be taken are indicated by *Roman* numerals placed *after* these symbols, thus : ♏xij ; fʒj ; f℥vj.

Table of U. S. Liquid Measure.

1 Wine Gallon=4 wine quarts.
1 Wine Quart=2 wine pints.
1 Wine pint=4 wine gills.
1 Wine Gill=4 U. S. fluidounces.
1 U. S. Fluidounce=8 fluidrachms.
1 U. S. Fluidrachm=60 U. S. minims.

Equivalents in Cubic Inches.

1 Wine Gallon=231.00 cubic inches.
1 Wine Quart=57.75 cubic inches.
1 Wine Pint=28·875 cubic inches.
1 U. S. Fluidounce=1.8046875 cubic inches.
1 U. S. Fluidrachm=0.2255859375 cubic inches.
1 U. S. Minim=0.003759765625 cubic inches.

Equivalents in Metric Terms.

1 Wine Gallon — 3.78530989 liters.
1 Wine Quart = 0 946327472 "
1 Wine Pint — 473.163736 Cubic-centimeters.
1 U. S. Fluidounce — 29.572734 "
1 U. S. Fluidrachm — 3.696592 "
1 U, S. Minim — 0.0616086 "

Equivalents in Imperial Measure.

1 Wine gallon —		0.83321182	Imperial	gallon.
1 "	"	"	3 33284728	"	quarts.
1 "	"	"	6.66569456	"	pints.
1 "	"	"	133.3138912	"	fluidounces.
1 "	"	"	1,066.5111296	"	fluidrachms.
1 "	"	"	63,990.667776	"	minims.

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1 Wine Quart —		0.83321182	Imperial	quart.
1 "	"	"	1.66642364	"	pints.
1 "	"	"	33.3284728	"	fluidounces.
1 "	"	"	266.6277824	"	fluidrachms.
1 "	"	"	1599.7666944	"	minims.

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1 Wine Pint —		0.83321182	Imperial	pint.
1 "	"	"	16.6642364	"	fluidounces.
1 "	"	"	133.3138912	"	fluidrachms.
1 "	"	"	7,998.833472	"	minims.

1 U. S. Fluidounce = 1.041139775 Imperial fluidounces.
1 " " " 8.3321182 " fluidrachms.
1 " " " 499.927092 " minims.

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1 U. S. Fluidrachm = 1.041139775 Imperial fluidrachms.
1 " " " 62.46838650 " minims.

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1 U. S. Minim = 1.041139775 Imperial minims.

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201. To Convert Wine Measure to Imperial Measure. Wine gallons may be converted in the corresponding number of Imperial gallons by multiplying with 0.83321.

Sufficiently accurate results for most practical purposes will be obtained by multiplying by 5 and dividing by 6, or by deducting one-sixth.

The same rules apply to the quarts and pints.

To convert U. S. fluidounces, fluidrachms or minims into the corresponding Imperial units, multiply by 1.04.

202. To Convert Wine Pints into Cubic-centimeters. *Multiply by 500 and deduct 10 per cent.*

The answer will be too small by nearly 49 wine pints for every 1,000 pints, or nearly 5 per cent. If 5 per cent be added to that answer the sum will be too small by only 22½ fluid ounces for every 1,000 pints, or 11 minims for every pint. *Ex.:* To find the number of Cubic-centimeters equivalent to 1,000 wine pints, multiply by 500 and deduct 10 per cent.; the answer will be 450,000, which is less by 23,163.74 than the exact number of Cubic-centimeters equivalent to 1,000 pints. Add to the answer (450,000) 5 per cent. (22,500). and the sum will be 472,500, which is only 663.74 less than the exact number of Cubic centimeters equivalent to 1,000 wine pints, 73,163.74.)

203. To convert pints into half-liters (or "metric s" of 500 Cubic-centimeters each): *Deduct 10 per cent.*

answer will be too small by nearly 49 pints for every 1,000 pints, per cent. If 5 per cent be added to the answer, the sum will be only 22½ fluid ounces for every 1,000 pints, or 11 minims for *Ex.:* To find the number of half-liters equivalent to 1,000 10 per cent.; the answer will be 900 half liters which is equal

to 450,000 Cubic-centimeters and less by 23,163.74 than the exact number of Cubic-centimeters contained in 1,000 pints. Add to the answer (900) 5 per cent. (45) and the sum will be 945 half-liters or 472,500 Cubic-centimers, which is only 663.74 less than the exact number of Cubic-centimeters equivalent to 1,000 pints (473,163.74).

204. The U. S. Fluidounce is equal to 480 U. S. minims, and to 500 Imperial minims.

It should for all ordinary practical purposes be regarded as equivalent to 32 Cubic-centimeters.

One-half fluidounce is commonly considered as equal to an average tablespoonful; but the average table-spoon probably holds nearer five fluid drachms.

Twenty-four U. S. fluidounces of water weighs (almost exactly) 25 avoirdupois ounces. at 60° F.

The symbol used to designate the fluid ounce is $f\bar{3}$.

205. In the United States it is not regarded as proper or safe to use the terms ounce and drachm to signify fluidounce and fluidrachm—a practice which is held legitimate in England. Although the established rule until the last revision of the U. S. Pharmacopœia was "solids by weight, and liquids by measure"—a rule which is still prevailing in actual practice not only in prescribing and dispensing but also in preparing medicines—the large influx of pharmacists from countries where fluid measures were never used renders it desirable that the distinction between the weight ounce and the fluid ounce shall be indicated, in order that there may be no ambiguity.

206. To convert U. S. Fluidounces into Cubic-centimeters: *Multiply by 32.*

The deviation from exactness is an excess of 8.2 per cent. By deducting 8 per cent. from it the answer will be too small by less than $4\frac{1}{2}$ minims for every 1,000 minims.

207. The U. S. Fluidrachm is for all ordinary practical purposes to be regarded as equal to 4 cubic-centimeters.

An average teaspoonful is generally considered to be commensurate with 1 fluidrachm, but is probably about $1\frac{1}{4}$ fluidrachm.

Both the U. S. fluidrachm and the Imperial fluidrachm are indicated by the symbol f℥ ; but the word *drachm* (or "dram") when referring to liquids is understood in England to mean the Imperial fluidrachm.

208. To convert U. S. Fluidrachms into Cubic-centimeters: *Multiply by 4.*

One meter is equal to 39.370432 inches.—(*Captain Clarke.*) Hence one Cubic-centimeter is equal to 0.06102538677 cubic inches, or to 16.2311678+ minims, (there being 61,440 minims in each wine-gallon of 231 cubic inches.) In preparing the above rule 1 cubic centimeter and 15 minims have been considered as equal quantities. The difference between 15 and 16.2311678 is 8.208 per cent., and hence the deviation from exactness corresponds to an excess of 82.08 minims for every 1,000 minims. To illustrate: 4,000 Cubic-centimeters would be (nearly) equivalent to 1,000 fluid drachms; but 4,000 Cubic-centimeters is equal to exactly 64,924.67 minims, while 1,000 fluid drachms is only 60,000 minims. The deviation from exactness, therefore, in the answer is equivalent to an excess of 4, 924.67 minims for every 1,000 fluidrachms, or about 41 minims for every fluid ounce, or 82.08 minims for every 1,000 minims, or 8.2 per cent.

To insure greater accuracy, if in any case deemed necessary, 8 per cent. may be deducted from the answer. The deviation from exactness will then be reduced to less than one-half of one per cent., the remainder being less than the exact equivalent sought by only 4.49 minims for every 1,000 minims, or less than $2\frac{1}{4}$ minims for every fluid ounce.

209. The Minim is the most convenient unit of fluid measure for medical and pharmacal purposes, being nearly equal to the average "drop" of pure water.

For all practical purposes it is most convenient to regard 16 minims as equal to 1 Cubic-centimeter (the actual number of U. S. minims in one Cubic-centimeter being 16.231.)

The U. S. minim as well as the Imperial minim is indicated by the symbol ♏ which is used both in writing and in typography.

210. To Convert U. S. Minims into Cubic-centimeters. *Divide by 16.*

The answer is too large by 0.44 per cent *Ex.:* To find the number of Cubic centimeters equal to 10,000 minims, divide by 16 ; the answer is 625. But 625 Cubic-centimeters is equivalent to exactly 10,044.38 minims, or 44.38

minims more than the correct answer. The deviation from exactness is, therefore, an excess of 4.4 minims in each 1,000 minims, or less than one-half of one per cent.

IMPERIAL MEASURE.

1 Imperial Bushel—4 pecks, or 32 quarts.
1 Imperial Peck—2 gallons, or 8 quarts.
1 Imperial Gallon—2 pottles, or 4 quarts.
1 Imperial Pottle—2 quarts, or 4 pints.
1 Imperial Quart—2 pints.
1 Imperial Pint—4 gills, or 20 Imperial fluidounces.
1 Imperial Gill—5 Imperial fluidounces.
1 Imperial Fluidounce—8 Imperial fluidrachms.
1 Imperial Fluidrachm—60 Imperial minims.

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211. The existing English weights and measures are called the Imperial System of Weights and Measures. This went into effect January 1st, 1826, superseding the wine measure and the old dry or Winchester measures for all purposes.

The measures used in medicine and pharmacy in Great Britain are the Imperial measures.

212. **The Imperial Gallon.**—The standard Imperial gallon is *the volume of 70,000 grains, or 10 avoirdupois pounds, of pure water at +62°.F.*, barometer at 30 inches.

It is generally stated to be equivalent to 277.274 cubic inches; but it would seem that 70,000 grains of water at +62°F., weighed in air under the ordinary conditions of atmospheric pressure and humidity, really measures 277.2404264 cubic inches.*

* NOTE.—By careful experimental determination Captain Henry Kater, of the British Standards Commission, found the apparent weight in air of one cubic inch of water to be equal to 252.456 grains. This determination was re-examined by Professor F. A. P. Barnard, of Columbia College, New York, who finds that the weight of one cubic inch of pure water, at 62°F., weighed in air at same temperature, under the ordinary conditions of

The Imperial gallon is divided into 4 quarts, equal to 8 pints.

213. **The Imperial Pint** is divided into 20 fluidounces. One Imperial pint of water at 62° F., weighs 20 avoirdupois ounces.

214. **The Imperial Gallon, Quart and Pint** are each very nearly 20 per cent. larger than the corresponding units of wine measure.

215. **The Imperial Fluidounce** is about 4 per cent. smaller than the U. S. fluidounce. It is commensurate with the avoirdupois ounce with relation to water at +62° F.

The Imperial fluidounce, like the U. S. fluidounce, is divided into 8 fluidrachms, and into 480 minims.

216. In England, the term *ounce*, when referring to a liquid, signifies the Imperial fluidounce. The term *drachm* is similarly employed. This is because the rule of "solids by weight and liquids by measure" has been so long and so thoroughly established there, that no misunderstanding is ever likely to arise from that practice.

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atmospheric pressure and humidity, and with brass weights, after deducting for displacement, is 252,48843 grains, and hence 70,000 grains of water under the same conditions measures 277.2404264 cubic inches.

In the table on page 89 the equivalents of the Imperial measures are given in accordance with the value of the Imperial gallon fixed by a former British law, which is 277.274 cubic inches. Although this law was repealed, tables of weights and measures continue to state that one Imperial gallon is equal to 277.274 cubic inches. But the Imperial gallon is "the volume of 70,000 grains of pure water at 62.°F." weighed in air, being thus primarily based upon the British Standard Troy pound and not upon the standard measure of length. In this, the wine gallon, when it had a fixed legal value, differed from the Imperial gallon, for the wine gallon was defined to be 231 cubic inches. But the wine gallon has also been referred to the standard for weight. Hence confusion has existed and does exist as to the real value of the wine gallon.

It is evident that the law ought to fix the value of the standard measures of capacity by one rule only. Man's laws may be based on nature's laws, but nature's laws cannot be altered. We can properly legislate that one

217. **One Imperial Minim** of pure water at +62° F. weighs only 0.911458 grain.

Five hundred Imperial minims is (almost exactly) equal to 1 U. S. fluidounce.

Like the U. S. minim the Imperial minim is frequently indicated in writing and in typography by the symbol ℿ.

Equivalents in Cubic Inches.

(1 Imperial Gallon=277.274 cubic inches.)*

1	Imperial	Bushel = 2218.191	cubic inches.
1	"	Peck =554.548	"
1	"	Gallon =277.274	"
1	"	Quart = 69.3185	"
1	"	Pint = 34-65925	"
1	"	Fluidounce = 1.7329625	"
1	"	Fluidrachm = 0.2166203	"
1	"	Minim = 0.00361034	"

* See note to par. 212.

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pound shall be equal to the weight of a given volume of water under certain conditions and then do our best to make our pound weight correctly represent that standard; but to legislate at the same time that a given volume of water shall be exactly equiponderant with the pound weight we have thus made would be an error based on the assumption that our means of determining weight and volume and their mutual relations are absolutely perfect. The error in the prototype kilogram noted elsewhere illustrates this point.

As Captain Clarke's determination of the length of the meter in inches (39.370432), and Professor Miller's determination of the weight of the actual prototype platinum Kilogram of the Archives in standard grains (15.43234874) are also accepted as correct, it follows that 1 liter is equal to 61.02538677 cubic inches, and that 1 Liter of pure water at 62°F. weighs, in air, 15,408.204 grains. Hence 1 liter is equal to about 0 220117 Imperial gallon, and 1 Imperal gallon to 4,543.0343185 Cubic-centimeters. It also follows that 1 Imperial gallon is equal to 1.200175 wine gallons, and 1 wine gallon to 0.83321182 Imperial gallon.

The table given above (on page 89) is the only one in which the old rule as to the number of cubic inches contained in an Imperial gallon has been used in this volume.

Equivalents in Metric Terms.

(1 Imperial Gallon = 277.240 cubic inches.*)

1 Imperial Bushel = 36.344274 liters.
1 " Peck " 9.086068 "

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1 Imperial Gallon = 4.54303432 liters.
1 " Quart " 1.13575858 "
1 " Pint " 0.56787929 "

*See note to par. 212.

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1 Imperial fluidounce = 28.393964 Cubic-centimeters.
1 " Fluidrachm " 3.549925 "
1 " Minim " 0.059154 "

Equivalents in Wine Measure, or U. S. Apothecaries' Measure.†

1 Imperial Gallon = 1.20017501 wine gallons,
1 " " " 4.800700 " quarts.
1 " " " 9.601400 " pints.
1 " " " 153.622401 U. S. fluidounces.
1 " " " 1,228.979206 " fluidrachms.
1 " " " 73,738.752369 " minims.

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1 Imperial Quart = 1.20017501 wine quarts.
1 " " " 2.40035001 " pints.
1 " " " 38.405600 U. S. fluidounces.
1 " " " 307.244802 " fluidrachms.
1 " " " 18,434.688092 " minims.

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1 Imperial Pint = 1.20017501 wine pints.
1 " " " 19.202800 U. S. fluidounces.
1 " " " 153.622401 " fluidrachms.
1 " " " 9,217.344046 " minims.

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† These equivalents are obtained on the assumption that a wine gallon is 231 cubic inches, and that the Imperial gallon is 277.240 cubic inches. (See note to par. 212.)

1 Imperial Fluidounce = 0.960140 U. S. fluidounce.
1 " " " 7.681120 " fluidrachms.
1 " " " 460.867202 " minims.

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1 Imperial Fluidrachm = 0.960140 U. S. fluidrachm.
1 " " " 57.608400 " minims.

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1 Imperial Minim = 0.960140 U. S. minim.

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218. To Convert Imperial Measure into U. S. Apothecaries' or Wine Measure.

Imperial gallons may be converted into the corresponding number of wine gallons by multiplying with 1.2, or by adding one-fifth. The same rule applies to the conversion of Imperial quarts and pints into wine quarts and wine pints.

Imperial fluidounces, fluidrachms and minims may be converted into U. S. apothecaries' fluidounces, fluidrachms and minims by multiplying with 0.96.

219. To Convert Imperial Measure into Metric:

Multiply gallons by 4.543
" quarts by 1.13576
" pints by .56788

The answer will be the corresponding number of liters.

AVOIRDUPOIS WEIGHT.

220. Commercial Weights.—All merchandise sold by weight, except the precious metals and precious stones, is now bought and sold by avoirdupois weight in all English speaking countries. Precious metals and jewelry are sold by Troy weight.

Avoirdupois weights are the only weights used in medicine and pharmacy in Great Britain.

221. Avoirdupois weight is also called Imperial weight (in

England). The value of the avoirdupois pound was defined by law in England in 1824 to be $\frac{7000}{5760}$ of the old standard troy pound—a brass weight made in 1758, which is now in the custody of the British Board of Trade.

222. The term "Avoirdupois."—Avoirdupois weight seems to have been used in England for many centuries, having been originally introduced by foreign merchants. The word "avoirdupois" was first used in the English statutes in 1335 (Report upon weights and measures by John Quincy Adams, 1821), and at that time meant "weighable" things.

Table of Avoirdupois Weight.

1 Ton = 20 hundred-weights, or 2,240 pounds.
1 Hundred-weight = 8 stones, or 112 pounds.
1 Stone = 14 pounds.
1 Pound = 16 ounces, or 7,000 grains.
1 Ounce = 16 drachms, or 437½ grains.
1 Drachm = 27$\frac{11}{32}$ grains.

Equivalents in Metric Terms.

1 Avoirdupois Pound = 453.592653 Grams.
1 " Ounce = 28.349541 "
1 " Drachm = 1.771846 "
1 Grain = 0.64799 "

Equivalents in Troy Weight.

1 Avoirdupois Pound = 1.215278 troy pounds.
1 " " = 14.583333 troy ounces.
1 " " = 291.6666 penny weights.
1 " " = 7,000 grains.

1 Avoirdupois Ounce = 0.911458 troy ounce.
1 " " = 18.22916 penny weights.
1 " " = 437.50 grains.

1 Avoirdupois Drachm = 1.13932 penny weights.
1 " " = 27.34375 grains.

1 Avoirdupois Grain = 1 troy grain.

Equivalents in U. S. Apothecaries' Weight.

1 Avoirdupois Pound = 14.583333 U. S. apothecaries' ounces.
1 " " = 116.666667 " " drachms.
1 " " = 350.000000 " " scruples.
1 " " = 70,000.000000 " " grains.

1 Avoirdupois Ounce = 0.911458 U. S. apothecaries' ounce.
1 " " = 7.291667 " " drachms.
1 " " = 21.875000 " " scruples.
1 " " = 437.500000 " " grains.

1 Avoirdupois Drachm = 0.455729 U. S. apothecaries' drachm.
1 " " = 1.367187 " " scruples.
1 " " = 27.343750 " " grains.

1 Avoirdupois Grain = 1 U. S. apothecaries' grain.

223. **The Avoirdupois Pound** is the only pound now used in England and America, except at the mints.

224. **To Convert Avoirdupois Pounds into Grams:** *Multiply by 500 and deduct 10 per cent.*

The answer will be too small by 55,433 grains for every 1,000 avoirdupois pounds, or about eight-tenths of one per cent. If 1 per cent. be added

to that answer, the sum will be too great by only 14,012 grains for every 1,000 avoirdupois pounds. or 14 grains for every pound. *Ex.:* To find the number of Grams equivalent to 1,000 avoirdupois pounds, multiply by 500 and deduct 10 per cent.; the answer will be 450,000, which is 3,592 less than the exact number of Grams equivalent to 1,000 avoirdupois pounds. Add to the answer (450,000), 1 per cent. (4,500), and the sum will be 454,500, which is only 908 more than the exact number of Grams equivalent to 1,000 avoirdupois pounds (453,592).

225. To Convert Avoirdupois Pounds into Kilograms: *Subtract 10 per cent. and divide the remainder by 2.*

The answer will be too small by about eight-tenths of one per cent. If one per cent. be added to it, the answer will be too large by only two-tenths of one per cent.

226. To Convert Avoirdupois Pounds in Half-kilograms (or "Metric Pounds" of 500 Grams each). *Deduct 10 per cent.*

The answer will be too small by 55,433 grains for every 1,000 avoirdupois pound, or about eight-tenths of one per cent. If one per cent. be added to the answer, the sum will be too great by only 14,012 grains for every 1,000 avoirdupois pounds, or 14 grains for each pound. *Ex.:* To find the number of half-kilograms equivalent to 1,000 avoirdupois pounds, deduct 10 per cent.; the answer will be 700 half-kilograms, which is equal to 450,000 Grams, and 3,592 less than the exact number of Grams equivalent to 1,000 avoirdupois pounds. Add to the answer (900) 1 per cent. (9), and the sum will be 909 half-kilograms, or 454,500 Grams, which is only 908 more than the exact number of Grams equivalent to 1,000 avoirdupois pounds (453,592).

227. The Avoirdupois Ounce is divided into 16 drachms. The avoirdupois drachm is, however, rarely used, and it is customary instead to write quantities below the ounce in common fractions of the ounce, as $\frac{1}{8}$ oz., $\frac{1}{16}$ oz., etc., or in grains.

One Imperial fluidounce of water at 62° F. weighs one avoirdupois ounce; but whilst the fluidounce is divided into 480 parts called minims, the avoirdupois ounce contains 437½ grains.

One hundred avoirdupois ounces of water measures (almost exactly) six wine pints or 96 U. S. fluid ounces at 60° F.

228. To Convert Avoirdupois Ounces into Grams. *Multiply by 30, and then deduct 5 per cent.*

The answer will be too great by about 5.30 avoirdupois ounces for every 1,000 avoirdupois ounces (about one-half of one per cent.), or 2.4 grains for every ounce. *Ex.:* To find the number of Grams equivalent to 1,000 avoirdupois ounces multiply by 30, and from the product deduct 5 per cent.; the answer will be 28,500, which is 150.46 more than the exact number of Grams equivalent to 1,000 avoirdupois ounces (28,349.54).

TROY WEIGHT.

229. Standard Troy Pound.—A brass weight, representing one troy pound, made in 1758, and formerly kept "in the custody of the Clerk of the House of Commons" (Law of 1824), but now in charge of the British Board of Trade, is the prototype for all weights for Great Britain. A copy of this "the original and genuine standard measure of weight" was procured for the United States by the American Minister at London in 1827, and this copy of the now legal standard for the weights of the British Empire is kept at the United States mint at Philadelphia, and is the legal standard measure of weight *for the coinage* of this country.

230. Origin of Troy Weight.—The troy pound was not used in England until, during the reign of Edward the First, the foreign commerce of the country began to expand. According to the opinion of John Quincy Adams the troy pound was introduced by merchants from Lombardy, who settled in England about the close of the 13th or the beginning of the 14th century, and who soon became the goldsmiths and bankers of the land.

231. It is to be observed that the troy pound was not only retained when the weights and measures of England were reconstructed in 1824, but was in fact made the basis of all weights as well as of the new Imperial gallon, notwithstanding that the troy pound had then as now but a very limited use,

whilst the avoirdupois pound was the actual standard by which commerce was carried on.

Mr. Davies Gilbert, one of the Commissioners of Weights and Measures, accounted for their action as follows :* "We were induced to preserve the troy weight because a the coinage had been uniformly regulated by it; and all medical prescriptions or formulæ now are, and always have been, estimated by troy weight, under a peculiar subdivision which the College of Physicians have expressed themselves most anxious to preserve."

But since Mr. Gilbert wrote the above, the troy weight has been discarded by the British Pharmacopœia.

Table of Troy Weight.

1 Troy Pound = 12 troy ounces, or 5,760 grains.
1 Troy Ounce = 20 penny weights, or 480 grains.
1 Penny Weight = 24 grains.

Equivalents in Metric Terms.

1 Troy Pound = 373.242954 Grams.
1 Troy Ounce = 31.103496 "
1 Penny Weight = 1.5551748 "
1 Grain = 64.798950 milligrams.

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232. **The Troy Ounce** is identical with the ounce of the U. S. apothecaries' weight, which is in fact generally called by the same name.

233. Troy weight has no drachm or scruple, which belong exclusively to the apothecaries' system of weights.

The troy grain is identical with the grain of both the avoirdupois and the apothecaries' systems.

* McCulloch's Dictionary of Commerce

234. The troy weight is now only used for the coinage, and for weighing precious metals and jewelry.

APOTHECARIES' WEIGHT.

235. Medicinal pounds divisible into 12 ounces, each ounce into 8 drachms, each drachm into three scruples, and each scruple into 20 grains, were formerly in use in most countries of Europe.

In France, Spain, Tuscany and Rome the medicinal pound was also divided into 12 ounces, each ounce into 8 drachms, and each drachm into 3 scruples; but each scruple contained 24 instead of 20 grains, and hence there were 6,912 grains to the pound in these countries.

The grain itself, however, varied in value in different countries.

Table of Apothecaries' Weight.

1 Pound = 12 ounces, or 5,760 grains.
1 Ounce = 8 drachms, or 480 grains.
1 Drachm = 3 scruples, or 60 grains.
1 Scruple = 20 grains.

236. In the United States the use of the pound in medicine and pharmacy has ceased. The ounce and the grain are the principal units used in this country, and were the only units referred to in the U. S. Pharmacopœia of 1870; but the drachm and the scruple are also in general use in prescribing and dispensing medicines.

The present Pharmacopœia of the United States refers to the *grain* in some of its working formulæ, but does not make use of ounces, drachms and scruples.

Equivalents in Metric Terms.

1 U. S. Apothecaries' Ounce = 31.103496 Grams.
1 " " Drachm = 3.887937 Grams.
1 U. S. Apothecaries' Scruple = 1.295979 Grams.
1 " " Grain = 64.798950 milligrams.

Equivalents in Troy Weight.

1 U. S. Apothecaries' Ounce = 1 troy ounce.
1 " " " = 20 penny weights.
1 " " " = 480 grains.

1 U. S. Apothecaries' Drachm = 2½ penny weights.
1 " " " = 60 grains.

1 U. S. Apothecaries' Scruple = ⅔ penny weight.
1 " " " = 20 grains.

1 U. S. Apothecaries' Grain = 1 Troy grain.

Equivalents in Avoirdupois Weight.

1 U. S. Apothecaries Ounce = 1.097143 avoirdupois ounce.
1 " " " = 17.554286 " drachms.
1 " " " = 480 " grains.

1 U. S. Apothecaries' Drachm = 2.194286 avoirdupois drachms.
1 " " " = 60 " grains.

1 U. S. Apothecaries' Scruple = 20 avoirdupois grains.

1 U. S. Apothecaries' Grain = 1 avoirdupois grain.

240. The U. S. Apothecaries' Ounce is identical with the troy ounce.

It is divided into 8 drachms of 60 grains each.

The symbol ʒ is used to designate it.

The troy or U. S. apothecaries' ounce is about 10 per cent. larger than the avoirdupois ounce, the exact difference between them being 42½ grains.

One U. S. fluidounce of water weighs 0.948311 troy ounce.

241. Containing 480 grains, the apothecaries' or troy ounce can be divided successively by two only down to 15.

Weights of 500 and 1,000 grains are frequently used, and the suggestion has sometimes been made to adopt a new ounce of 500 grains on the ground that this would bring it into greater harmony with our arithmetic. If this could be done at all, the new ounce ought to consist of 500 such grains as would be commensurate with the Imperial minim, as it so happens that the U. S. fluidounce is almost exactly 500 Imperial minims. But such a change will hardly be made, as the advantages gained would be too trifling to justify it.

242. An ounce of 32 Grams, if it could be adopted, each Gram to be divided into 16 grains, would be a decided improvement, because it would firmly fix the value of our weights, connect them in a simple relation with the universal system, and especially because it would, in connection with a corresponding fluidounce of 32 Cubic-centimeters, each cubic-centimeter to be divided into 16 minims, give us the most natural and perfect system of weights and measures for adjusting the proportional strength of liquid preparations. (See par. 73.)

243. For all ordinary practical uses the apothecaries' ounce can safely and most conveniently be regarded as equal to 32 Grams.

244. **To Convert Troy or U. S. Apothecaries' Ounces into Avoirdupois Ounces:** *Add 10 per cent.*

The answer will be too large by less than $\frac{3}{10}$ of one per cent.

To Convert Troy or U. S. Apothecaries' Ounces ʒ: *Multiply by 32.*

will be too large by less than 2.9 per cent. If 3 per cent.

be deducted from it, the answer will then be too small by about two-tenths of one per cent,, or about one grain for each troy ounce.

246. **The U. S. Apothecaries' Drachm** is divided into 60 grains. It is also divided into 3 scruples of 20 grains each.

To designate drachms the symbol ʒ is used.

One drachm is equal to 4 Grams.

A drachm divided into 64 grains would be far more useful than one divided into 60 grains.

247. **To Convert U. S. Apothecaries' Drachms into Grams:** *Multiply by 4.*

The deviation from exactness corresponds to an excess of 28.82 grains for every 1,000 grains. To illustrate: By this rule 4,000 grams would be (nearly) equivalent to 1,000 apothecaries' drachms; but 4,000 Grams is equal to exactly 61,729.40 troy grains, while 1,000 apothecaries' drachms is only 60,000 troy grains. The deviation from exactness, therefore, is equivalent to an excess of 1.729.40 troy grains for every 1,000 apothecaries' drachms, or about 14 grains for every troy ounce, or 28.82 grains for every 1,000 grains, or less than 2.9 per cent.

To insure greater accuracy, if in any case deemed necessary, 3 per cent. may be deducted from the answer. The deviation from exactness will then be reduced to one fifth of one per cent., the remainder being less than the exact equivalent sought by only 2.04 grains for every 1,000 grains, or about one grain for every troy ounce.

248. **The Scruple.**—This unit is divided into 20 grains, and the symbol ℈ is used to designate it.

It is equal to 1⅓ Grams.

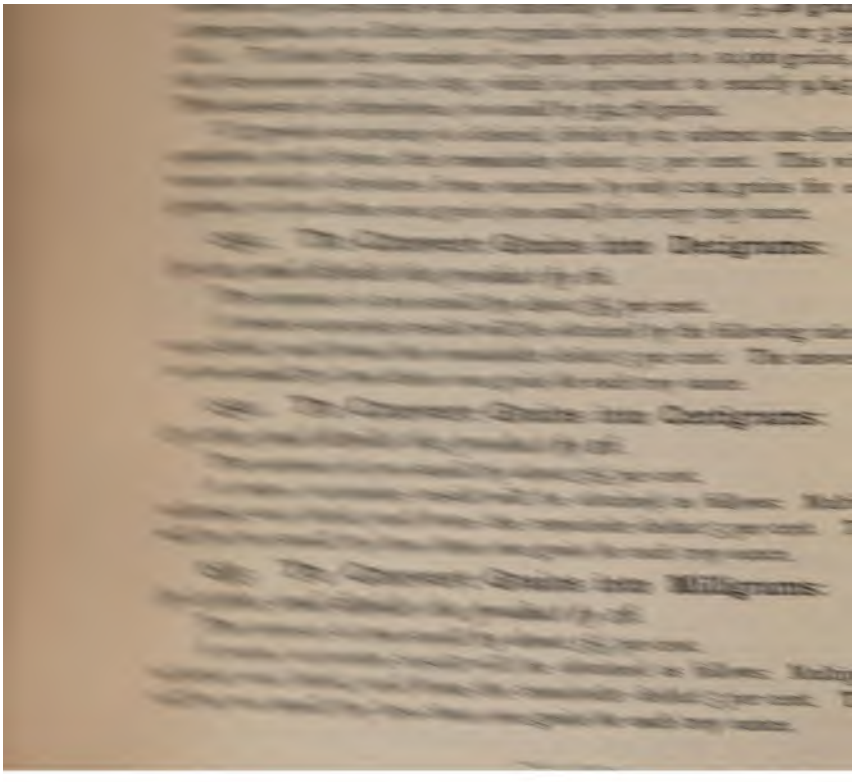
249. **The Grain.**—This is the connecting link between the Troy, Apothecaries' and Avoirdupois weights, the grain being the same in all.

One grain is very nearly $\frac{1}{16}$ Gram, and for all ordinary practical purposes it is most convenient to so regard it.

One U. S. minim of pure water weighs 0.948311 grain, and one Imperial minim weighs 0.91051 grain at 22° C.

One grain of water at 22° C., weighed in air, measures 1.0545 U. S. Minims, or 1.0983 Imperial Minims.

In writing and typography it is customary to signify grains by the abbreviation gr., the number being placed after it in Roman numerals, thus: gr. xxx.



255. They are based on the assumption that 16 grains make 1 Gram, and 32 Grams make 1 troy ounce; and that 16 minims make 1 Cubic-centimeter (or fluigram), and 32 Cubic-centimeters (or fluigrams) make 1 fluidounce.

Grains in Grams.

$\frac{1}{2000}$	Grain	=	0.03125	(or $\frac{1}{32}$)	Mill.	$\frac{3}{4}$	Grain	=	46.88 (or 46$\frac{7}{8}$) Mills.
$\frac{1}{1000}$	"	"	0.0625	(or $\frac{1}{16}$)	"	$\frac{4}{5}$	"	"	50.00 (or 50) "
$\frac{1}{750}$	"	"	0.0833	(or $\frac{1}{12}$)	"	$\frac{7}{8}$	"	"	54.69 (or 54$\frac{3}{8}$) "
$\frac{1}{625}$	"	"	0.1000	(or $\frac{1}{10}$)	"	1	"	"	62.50 (or 62$\frac{1}{2}$) "
$\frac{1}{500}$	"	"	0.125	(or $\frac{1}{8}$)	"	1$\frac{1}{2}$	"	"	93.75 (or 93$\frac{3}{4}$) "
$\frac{1}{375}$	"	"	0.166	(or $\frac{1}{6}$)	"	1$\frac{6}{10}$	"	"	10.00 (or 10) Cents.
$\frac{1}{312}$	"	"	0.200	(or $\frac{1}{5}$)	"	2	"	"	12.50 (or 12$\frac{1}{2}$) "
$\frac{1}{250}$	"	"	0.250	(or $\frac{1}{4}$)	"	3	"	"	18.75 (or 18$\frac{3}{4}$) "
$\frac{1}{208}$	"	"	0.300	(or $\frac{3}{10}$)	"	4	"	"	25.00 (or 25) "
$\frac{1}{187}$	"	"	0.333	(or $\frac{1}{3}$)	"	5	"	"	31.25 (or 31$\frac{1}{4}$) "
$\frac{1}{156}$	"	"	0.400	(or $\frac{2}{5}$)	"	6	"	"	37.50 (or 37$\frac{1}{2}$) "
$\frac{1}{125}$	"	"	0.500	(or $\frac{1}{2}$)	"	7	"	"	43.65 (or 43$\frac{3}{4}$) "
$\frac{1}{100}$	"	"	0.625	(or $\frac{5}{8}$)	"	8	"	"	50.00 (or 50) "
$\frac{1}{83}$	"	"	0.750	(or $\frac{3}{4}$)	"	9	"	"	56.25 (or 56$\frac{1}{4}$) "
$\frac{1}{70}$	"	"	0.785	(or $\frac{7}{8}$)	"	10	"	"	62.50 (or 62$\frac{1}{2}$) "
$\frac{1}{63}$	"	"	1.00	(or 1)	"	12	"	"	75.00 (or 75) "
$\frac{1}{50}$	"	"	1.25	(or 1$\frac{1}{4}$)	Mills.	14	"	"	87.50 (or 87$\frac{1}{2}$) "
$\frac{1}{38}$	"	"	1.66	(or 1$\frac{2}{3}$)	"	16	"	"	1.00 (or 1) Gram.
$\frac{1}{31}$	"	"	2.00	(or 2)	"	20	"	"	1.25 (or 1$\frac{1}{4}$) "
$\frac{1}{25}$	"	"	2.50	(or 2$\frac{1}{2}$)	"	24	"	"	1.50 (or 1$\frac{1}{2}$) "
$\frac{1}{21}$	"	"	3.00	(or 3)	"	30	"	"	1.88 (or 1$\frac{8}{8}$) "
$\frac{1}{16}$	"	"	4.00	(or 4)	"	32	"	"	2.00 (or 2) "
$\frac{1}{13}$	"	"	5.00	(or 5)	"	36	"	"	2.25 (or 2$\frac{1}{4}$) "
$\frac{1}{10}$	"	"	6.25	(or 6$\frac{1}{4}$)	"	40	"	"	2.50 (or 2$\frac{1}{2}$) "
$\frac{1}{8}$	"	"	7.81	(or 7$\frac{8}{10}$)	"	48	"	"	3.00 (or 3) "
$\frac{1}{6}$	"	"	10.42	(or 10$\frac{4}{10}$)	"	56	"	"	3.50 (or 3$\frac{1}{2}$) "
$\frac{1}{5}$	"	"	12.50	(or 12$\frac{1}{2}$)	"	60	"	"	3.75 (or 3$\frac{3}{4}$) "
$\frac{1}{4}$	"	"	15.63	(or 15$\frac{6}{8}$)	"	64	"	"	4.00 (or 4) "
$\frac{1}{3}$	"	"	20.83	(or 20$\frac{4}{8}$)	"	72	"	"	4.50 (or 4$\frac{4}{8}$) "
$\frac{3}{8}$	"	"	23.44	(or 23$\frac{7}{8}$)	"	80	"	"	5.00 (or 5) "
$\frac{2}{5}$	"	"	25.00	(or 25)	"	90	"	"	5.63 (or 5$\frac{6}{8}$) "
$\frac{1}{2}$	"	"	31.25	(or 31$\frac{1}{4}$)	"	96	"	"	6.00 (or 6) "
$\frac{3}{5}$	"	"	37.50	(or 37$\frac{1}{2}$)	"	100	"	"	6.25 (or 6$\frac{1}{4}$) "
$\frac{2}{3}$	"	"	41.66	(or 41$\frac{2}{3}$)	"	112	"	"	6.00 (or 7("

250. To Convert Grains into Grams: *Divide by 16.*

The difference between 16 and 15.43234874 amounts to just 0.56765126, or 3.547820375 per cent. of 16. The deviation from exactness in the answers arrived at by this rule will be uniformly too small by 35.48 grains in every 1,000 grains, or a little over 17 grains for every troy ounce, or 3.55 per cent. *Ex.:* To find the number of grams equivalent to 10,000 grains, divide by 16; the answer will be 625, which is equivalent to exactly 9,645.22 grains. This answer is, therefore, too small by 354.78 grains.

If greater accuracy is desired, divide by 10, subtract one-third from the quotient, and from the remainder deduct 3 per cent. This will give an answer which deviates from exactness by only 2.04 grains for every 1,000 grains, or less than one grain (too small) for every troy ounce.

251. To Convert Grains into Decigrams: *Multiply by 10, and divide the product by 16.*

The answer is too small by about 3½ per cent.

A more accurate result will be obtained by the following rule: Subtract one-third, and from the remainder deduct 3 per cent. The answer will then be too small by less than one grain for each troy ounce.

252. To Convert Grains into Centigrams: *Multiply by 100, and divide the product by 16.*

The answer is too small by about 3½ per cent.

A more accurate result will be obtained as follows: Multiply by 10, subtract one third, and from the remainder deduct 3 per cent. The answer will be too small by less than one grain for each troy ounce.

253. To Convert Grains into Milligrams: *Multiply by 1,000, and divide the product by 16.*

The answer is too small by about 3½ per cent.

A more accurate result will be obtained as follows: Multiply by 100, subtract one third, and from the remainder deduct 3 per cent. The answer will be too small by less than one grain for each troy ounce.

APPROXIMATE EQUIVALENTS OF U. S. APOTHECARIES' WEIGHTS AND FLUID MEASURES IN METRIC WEIGHTS AND MEASURES.

254. These equivalents are recommended as the most convenient for all ordinary purposes in practical medicine and pharmacy, and are sufficiently accurate.

255. They are based on the assumption that 16 grains make 1 Gram, and 32 Grams make 1 troy ounce; and that 16 minims make 1 Cubic-centimeter (or fluigram), and 32 Cubic-centimeters (or fluigrams) make 1 fluidounce.

Grains in Grams.

$\frac{1}{2000}$	Grain	=	0.03125	(or $\frac{1}{32}$)	Mill.	$\frac{3}{4}$	Grain	=	46.88 (or $46\frac{7}{8}$) Mills.
$\frac{1}{1000}$	"	"	0.0625	(or $\frac{1}{16}$)	"	$\frac{4}{5}$	"	"	50.00 (or 50) "
$\frac{1}{750}$	"	"	0.0833	(or $\frac{1}{12}$)	"	$\frac{7}{8}$	"	"	54.69 (or $54\frac{2}{3}$) "
$\frac{1}{625}$	"	"	0.1000	(or $\frac{1}{10}$)	"	1	"	"	62 50 (or $62\frac{1}{2}$) "
$\frac{1}{500}$	"	"	0.125	(or $\frac{1}{8}$)	"	$1\frac{1}{2}$	"	"	93.75 (or $93\frac{3}{4}$) "
$\frac{1}{375}$	"	"	0.166	(or $\frac{1}{6}$)	"	$1\frac{6}{10}$	"	"	10.00 (or 10) Cents.
$\frac{1}{312}$	"	"	0.200	(or $\frac{1}{5}$)	"	2	"	"	12.50 (or $12\frac{1}{2}$) "
$\frac{1}{250}$	"	"	0.250	(or $\frac{1}{4}$)	"	3	"	"	18.75 (or $18\frac{3}{4}$) "
$\frac{1}{208}$	"	"	0.300	(or $\frac{3}{10}$)	"	4	"	"	25.00 (or 25) "
$\frac{1}{187}$	"	"	0.333	(or $\frac{1}{3}$)	"	5	"	"	31.25 (or $31\frac{1}{4}$) "
$\frac{1}{156}$	"	"	0.400	(or $\frac{2}{5}$)	"	6	"	"	37.50 (or $37\frac{1}{2}$) "
$\frac{1}{125}$	"	"	0.500	(or $\frac{1}{2}$)	"	7	"	"	43.65 (or $43\frac{3}{4}$) "
$\frac{1}{100}$	"	"	0.625	(or $\frac{5}{8}$)	"	8	"	"	50.00 (or 50) "
$\frac{1}{83}$	"	"	0.750	(or $\frac{3}{4}$)	"	9	"	"	56.25 (or $56\frac{1}{4}$) "
$\frac{1}{70}$	"	"	0.785	(or $\frac{7}{8}$)	"	10	"	"	62.50 (or $62\frac{1}{2}$) "
$\frac{1}{62}$	"	"	1.00	(or 1)	"	12	"	"	75.00 (or 75) "
$\frac{1}{50}$	"	"	1.25	(or $1\frac{1}{4}$)	Mills.	14	"	"	87.50 (or $87\frac{1}{2}$) "
$\frac{1}{38}$	"	"	1.66	(or $1\frac{2}{3}$)	"	16	"	"	1.00 (or 1) Gram.
$\frac{1}{31}$	"	"	2.00	(or 2)	"	20	"	"	1.25 (or $1\frac{1}{4}$) "
$\frac{1}{25}$	"	"	2.50	(or $2\frac{1}{2}$)	"	24	"	"	1.50 (or $1\frac{1}{2}$) "
$\frac{1}{21}$	"	"	3.00	(or 3)	"	30	"	"	1.88 (or $1\frac{8}{8}$) "
$\frac{1}{16}$	"	"	4.00	(or 4)	"	32	"	"	2.00 (or 2) "
$\frac{1}{13}$	"	"	5.00	(or 5)	"	36	"	"	2.25 (or $2\frac{1}{4}$) "
$\frac{1}{10}$	"	"	6.25	(or $6\frac{1}{4}$)	"	40	"	"	2.50 (or $2\frac{1}{2}$) "
$\frac{1}{8}$	"	"	7.81	(or $7\frac{8}{10}$)	"	48	"	"	3.00 (or 3) "
$\frac{1}{6}$	"	"	10.42	(or $10\frac{4}{10}$)	"	56	"	"	3.50 (or $3\frac{1}{2}$) "
$\frac{1}{5}$	"	"	12.50	(or $12\frac{1}{2}$)	"	60	"	"	3.75 (or $3\frac{3}{4}$) "
$\frac{1}{4}$	"	"	15.63	(or $15\frac{6}{8}$)	"	64	"	"	4.00 (or 4) "
$\frac{1}{3}$	"	"	20.83	(or $20\frac{4}{6}$)	"	72	"	"	4.50 (or $4\frac{1}{2}$) "
$\frac{3}{8}$	"	"	23.44	(or $23\frac{3}{8}$)	"	80	"	"	5.00 (or 5) "
$\frac{2}{5}$	"	"	25.00	(or 25)	"	90	"	"	5.63 (or $5\frac{5}{8}$) "
$\frac{1}{2}$	"	"	31.25	(or $31\frac{1}{4}$)	"	96	"	"	6.00 (or 6) "
$\frac{3}{5}$	"	"	37.50	(or $37\frac{1}{2}$)	"	100	"	"	6.25 (or $6\frac{1}{4}$) "
$\frac{2}{3}$	"	"	41.66	(or $41\frac{2}{3}$)	"	112	"	"	6.00 (or 7(

120	Grains	=	7.50 (or 7½)	Grams.	320	Grains =	20.00 (or 20) Grams.
128	"	"	8.00 (or 8)	"	328	" "	20.50 (or 2 ½) "
136	"	"	8.50 (or 7½)	"	336	" "	21.00 (or 21) "
144	"	"	9.00 (or 9)	"	344	" "	21.50 (or 21½) "
152	"	"	9.50 (or 9½)	"	352	" "	22.00 (or 22) "
160	"	"	10.00 (or 10)	"	360	" "	22.50 (or 22½) "
168	"	"	10.50 (or 10½)	"	368	" "	23.00 (or 23) "
176	"	"	11 00 (or 11)	"	376	" "	23.50 (or 23½) "
184	"	"	11.50 (or 11½)	"	384	" "	24.00 (or 24) "
192	"	"	12.00 (or 12)	"	392	" "	24.50 (or 24½) "
200	"	"	12.50 (or 12½)	"	400	" "	25.00 (or 25) "
208	"	"	13.00 (or 13)	"	408	" "	25.50 (or 25½) "
216	"	"	13.50 (or 13½)	"	416	" "	26.00 (or 26) "
224	"	"	14.00 (or 14)	"	424	" "	26.50 (or 26½) "
232	"	"	14.50 (or 24½)	"	432	" "	27.00 (or 27) "
240	"	"	15.00 (or 15)	"	440	" "	27 50 (or 27½) "
248	"	"	15.50 (or 15½)	"	448	" "	28.00 (or 28) "
256	"	"	16.00 (or 16)	"	456	" "	28.50 (or 28½) "
264	"	"	16.50 (or 16½)	"	464	" "	29.00 (or 29) "
272	"	"	17.00 (or 17)	"	472	" "	29.50 (or 29½) "
280	"	"	17.50 (or 17½)	"	480	" "	30.00 (or 30) "
288	"	"	18.00 (or 18)	"	488	" "	30.50 (or 30½) "
296	"	"	18.50 (or 18½)	"	496	" "	31.00 (or 31) "
304	"	"	19.00 (or 19)	"	504	" "	31.50 (or 31½) "
312	"	"	19.50 (or 19½)	"	512	" "	32.00 (or 32) "

Drachms in Grams.

1/64	Drachm	=	0·0625	(or 1/16)	Gm.	6 Drachms	= 24 Grams.
1/32	"	"	0.125	(or 1/8)	"	7 "	" 28 "
1/16	"	"	0.25	(or 1/4)	"	8 "	" 32 "
1/8	"	"	0.50	(or 1/2)	"	9 "	" 36 "
1/4	"	"	1.00	(or 1)	"	10 "	" 40 "
1/2	"	"	2 Grams.			11 "	" 44 "
	"	"	3 "			12 "	" 48 "
	"	"	4 "			13 "	" 52 "
		"	8 "			14 "	" 56 "
		"	12 "			15 "	" 60 "
			16 "			16 "	" 64 "
			"			20 "	" 80 "

Troy Ounces in Grams.

$\frac{1}{31}$	Troy Ounce	—	1 Gram.
$\frac{1}{16}$	"	"	2 Grams.
$\frac{1}{8}$	"	"	4 "
$\frac{1}{4}$	"	"	8 "
$\frac{3}{8}$	"	"	12 "
$\frac{1}{2}$	"	"	16 "
$\frac{5}{8}$	"	"	20 "
$\frac{3}{4}$	"	"	24 "
$\frac{7}{8}$	"	"	28 "
1	"	"	32 "
$1\frac{1}{2}$	Troy Ounces	"	48 "
2	"	"	64 "
3	"	"	96 "
4	"	"	128 "
5	"	"	160 "
6	"	"	192 "
7	"	"	224 "
8	"	"	256 "
9	"	"	288 "
10	Troy Ounces	—	320 Grams.
11	"	"	352 "
12	"	"	384 "
13	"	"	416 "
14	"	"	448 "
15	"	"	480 "
16	"	"	512 "
17	"	"	544 "
18	"	"	596 "
19	"	"	608 "
20	"	"	640 "
30	"	"	960 "
40	"	"	1,280 "
50	"	"	1,600 "
60	"	"	1,920 "
70	"	"	2,240 "
80	"	"	2,560 "
90	"	"	2,880 "
100	"	"	3,200 "

Minims in Cubic-centimeters (or Fluigrams).

$\frac{1}{15}$	Minim	—	0.005 C.c.
$\frac{1}{10}$	"	"	0.006 "
$\frac{1}{9}$	"	"	0.007 "
$\frac{1}{8}$	"	"	0.008 "
$\frac{1}{7}$	"	"	0.009 "
$\frac{1}{6}$	"	"	0.010 "
$\frac{1}{5}$	"	"	0.012 "
$\frac{1}{4}$	"	"	0.016 "
$\frac{1}{3}$	"	"	0.02 "
$\frac{1}{2}$	"	"	0.03 "
$\frac{2}{3}$	"	"	0.04 "
$\frac{5}{8}$	"	"	0.05 "
1	"	"	0.06 "
$1\frac{1}{2}$	"	"	0.09 "
2	"	"	0.12 "
3	"	"	0.18 "
4	Minims	—	0.25 C.c.
5	"	"	0.30 "
8	"	"	0.50 "
12	"	"	0.75 "
16	"	"	0.75 "
24	"	"	$1\frac{1}{2}$ "
32	"	"	2 "
48	"	"	3 "
64	"	"	4 "
80	"	"	5 "
96	"	"	6 "
112	"	"	7 "
128	"	"	8 "
144	"	"	9 "
160	"	"	10 "

Fluidrachms in Cubic-centimeters (or Fluigrams).

Fluidrachm	=	Fluigram	Fluidrachms	=	Fluigrams
¼		1	21		
½		2	22		
¾		3	23		
1		4	24		
1½		6	25		
2		8	26		
3		12	27		
4		15	28		
5		19	29		
6		23	30		

Fluidounces in Cubic-centimeters (or Fluigrams).

Fluidounce	=	Gram.	Fluidounces	=	Grams.
¼		7	1		32
½		15	2		64
¾		22	3		96
1		30	4		128
2		60	5		160
3		90	6		192
4		120	7		224
5		150	8		256
6		180	10		308
7		210	20		610
8		240	30		900
9		270	40		1,200
10		300	50		1,500

WEIGHING AND MEASURING.

256. **Weighing and Measuring** are delicate, important, and constantly recurring pharmaceutical operations, requiring care, precision, and good instruments. Accurate results are attainable by both processes; but when extreme precision is necessary, as in some of the operations of the physicist or the analytical chemist, the balance and weights afford the best means of arriving at reliable and exact determinations.

257. In medicine and pharmacy weighing and measuring are of equal importance and applicability, and with a reasonable degree of care and skill will afford equally accurate results, solids being always weighed.

258. **Gravimetric Methods.**—When all the substances operated upon are weighed, the process is "gravimetric." Thus a quantitative chemical analysis, in which the results are determined and expressed by weight, is a gravimetric analysis. It is also called "stathmetometric" or "stathmetic."

A pharmacal working formula in which all the ingredients or materials are prescribed in quantities or proportions by weight is a gravimetric formula, with gravimetric proportions, and the strength of the resulting product, if a mixture, solution or dilution, is indicated gravimetrically. The formulæ, processes and strength of the liquid preparations of the U. S. Pharmacopœia of 1880 are all gravimetric, except those of the fluid extracts.

Both solids and liquids can readily be weighed.

259. **Volumetric Methods.**—When liquid ingredients or materials are used in a formula, process or preparation, the proportions may be either gravimetric or volumetric, or both.

In pharmacy only liquids are measured. The working formulæ for the liquid preparations of the U. S. Pharmacopœia of 1870 and all preceding American pharmacopœias, and for the liquid preparations of the several British Pharmacopœias, are volumetric, because all the liquid substances referred to in them are prescribed to be taken by measure, and the strength of the final product is indicated volumetrically.

A quantitative chemical analysis in which the results are indicated by volumes, is a volumetric analysis.

260. Simple Numerical Proportions.—The proportions and the strength of pharmacal preparations in which all quantities are weighed may be expressed in purely mathematical ratios. For instance, the preparation Trituratio Elaterini of the Pharmacopœia of 1880 is a powder containing 10 per cent. by weight of elaterin; the Liquor Acidi Arseniosi is a solution containing 1 per cent. by weight of arsenious oxide; and the Aqua Amygdalæ Amaræ is a solution containing 1 per mill or $\frac{1}{10}$ per cent. by weight of oil of bitter almond.

In formulæ and preparations where all substances are measured the relative proportions can also be expressed in equally simple mathematical terms. Thus the Alcohol Dilutum of the Pharmacopœia of 1870 was a mixture containing 50 per cent. by volume of the official alcohol.

But in formulæ and preparations where both weights and measures are simultaneously used, the proportions cannot be expressed in decimal, centesimal or millesimal ratios, because different substances have different specific weights, and because the units of weight and measure (except those of the metric system) are not commensurate.

261. Solids by Weight and Liquids by Measure.—
his terse expression is used to describe the practice pursued
l English speaking countries in the construction of medical
iptions and pharmacal formulæ, in preparing and dis-
; medicines, and in fixing and expressing their strength.

When the weights and measures employed have no parallel commensurate units, it follows that when this practice is adopted the proportions cannot easily be indicated in such simple mathematical terms as percentage.

262. **Decimal Ratios.**—Whenever whole groups of pharmacal preparations can be made of the same proportional strength without detriment, such equalization is desirable as an aid to the memory. At the same time it must not be forgotten that although arithmetical calculations naturally become materially simplified by bringing the numerical proportions into harmony with our decimal system of notation, the labor saved to the pharmacist by employing exclusively gravimetric methods is in reality insignificant, and that it is far more important that the relative *medicinal strength* and dose of the preparation shall be readily seen. Decimal, centesimal and millesimal proportions, however simple and easily remembered in a purely mathematical sense, will after all be found as a very general rule to obscure the therapeutic strength and dose of the preparations, and especially of liquids.

263. In the U. S. Pharmacopœia of 1880 weights and measures are used simultaneously in the working formulæ for fluid extracts. The formulæ for pills, troches, and Seidlitz powders are expressed in definite quantities by weight, using both the grains and the Grams side by side.

"Parts by weight" is the form adopted for all other preparations. Thus three different methods are employed.

264. **Definite Quantities.**—In the formulæ for pills, troches and other preparations divided into parts of definite weight, the most natural method is that of prescribing definite quantities of the several ingredients to make a definite number of the pills or troches. The application of proportions expressed in parts to such formulæ would be absurd.

Definite quantities can also be used without disadvantage in all other pharmacal formulæ, and physicians' prescriptions

are invariably constructed in definite quantities by weight or measure, or both.

265. In making preparations in which both solids and liquids are used as materials or ingredients, weights are necessarily employed for the solid substances, while the liquids may be either weighed or measured.

If the liquid ingredients are weighed, and the final product also brought to a definite proportion by weight, it is possible to state all the proportions in parts: that is, without reference to definite weight units.

If, on the other hand, the liquids are prescribed and used by measure, the proportions to be used must necessarily be fixed by numbers referring to definite units of weight for the solids and units of measure for the liquids, as done in the U. S. Pharmacopœia of 1870.

266. A review of the tinctures, wines, syrups and spirits of the U. S. Pharmacopœia of 1880 discloses the fact that uniform numerical proportions by weight are not attainable unless radical changes are made. Such changes cannot be made except very gradually without causing confusion and risk.

The tinctures are at present: 4, 5, 8, 10, 12, 15, 20, 25, 35, 40, 50 and 65 per cent. by weight.

The wines are: 4, 6, 7, 8, 10, 15 and 40 per cent.

The spirits are: 1, 2.4, 3, 4, 6 and 10 per cent.

The syrups are: 1, 2, 4, 5, 6, 8, 9, 10, 12, 15, 16, 20, 33 and 40 per cent.

It is, of course, scarcely possible to bring any compound preparations under this rule with advantage.

267. **Liquids** are the only substances in the handling of which we are called upon to choose between weighing and measuring. As to accuracy, either method is as good as the other in pharmacy. As to convenience, measure is decidedly superior.

In English speaking countries, however, liquids are not

weighed except to a very limited extent, and only in making pharmacal preparations for stock.

The utility of decimal and centesimal proportions, and of exclusively gravimetric methods as applied to liquids, frequently ends with the construction of the working formula, and scarcely ever extends beyond the finishing of the preparation.

To the physician who is to use these preparations the knowledge of their respective strengths in per cent. by weight is useless, as he does not prescribe by percentage, nor in parts, nor exclusively by weight, having no choice as to the employment of measures for apportioning the doses of liquids.

The Balance.

268. The Lever Balance is a uniform inflexible beam, supported horizontally near its center of gravity upon knife edges, which admit of free and equal oscillations. In a properly constructed balance the arms are of equal length, weight and form, and the pans or scales, also, with their appendages, must be equal. The center of gravity of the lever, or beam, should be situated immediately below the fulcrum, which must rest upon a plane somewhat above the horizontal line connecting the points of attachment of the pans at the extreme ends of the arms.

A balance is commonly called "a pair of scales."

269. In order that the balance may be sensitive, the beam should be as light as is consistent with its inflexibility, and the arms long. The relative positions of the center of gravity and the fulcrum influence materially the character of the instrument. If the center of gravity be too far below the fulcrum, the vibrations will be rapid and of short duration, and a considerable weight will be required to turn the lever. By eleva-

ting the center of gravity, the vibrations will become slower, require a smaller impulse, and a longer period of time will pass before the beam again attains a state of rest. When the fulcrum, or center of oscillation, and the center of gravity coincide in the plane joining the points of suspension of the pans, no vibrations can take place, but the least possible weight will depress the beam on one or the other side, the important indications afforded by the extent and velocity of the oscillations being thus lost. In balances intended for heavy loads the center of gravity is therefore lower than in delicate instruments, the point gained by this arrangement being that the beam will oscillate more readily, though it requires a larger weight to start it. The quality of the knife edges (usually of nickel, steel or agate) and the hardness of the planes or curves upon which they rest, are also important features in perfect balances.

It is best that the support of the beam be a fixed pillar.

270. A delicate balance should be furnished with such appliances as will afford convenient supports both to the pans (independent of the beam) and the beam (independent of its knife edges), in order that the delicate edges of suspension may not sustain injury from pressure or shocks.

271. **Verification.**—In purchasing a balance it is not safe to accept the instrument as faultless until it has been tested, and, indeed, every balance requires to be examined from time to time, no matter how frequently or rarely used. The beam may be considered perfect if, when supported on its fulcrum with the pans detached, it oscillates readily and equally, gradually attaining its horizontal position of rest, these results being unaffected by reversing it. When the pans are attached the beam should still preserve its equilibrium, whether the pans be transposed, empty, or lightly or heavily loaded, even if the beam itself be reversed, and a transposition of the loads in the pans should not affect this result.

272. **The Indicator.**—Each balance has an "indicator"

somewhat in the form of the minute hand of a clock, and a short scale forming the segment of a circle to which the indicator points. The indications of the balance are accurately read by observing the coincidence of the point of the indicator with the zero line in the center of the scale.

In "box-scales" the indicator consists of two arrow points which meet in equilibrium.

273. **Compound Lever Balances**, inverted so that the pans are above the beam and supported upon rods so constructed as to retain their vertical position during oscillation, are also much used. In the trade one kind are called "box scales."

The advantages of the so-called box scales are chiefly that they can be better protected from injury, all the delicate portions of the mechanism being contained within the box, and that they are more convenient for constant use. They are, however, less sensitive than the best balances constructed as described in paragraphs 268 and 269.

274. **Steelyards.**—Lever balances with unequal arms and movable support are also used. The common steelyard is of this description.

275. Lever balances with graduated scales and sliding weights on their beams are not uncommon.

276. **Scales for Weighing Liquids.**—Liquids can be weighed on almost any kind of lever balances, the vessels to contain the liquid being placed in the center of one pan and the tare on the opposite pan.

Special scales for this purpose ("Laboratory scales"), provided with convenient graduated beams and sliding weights are however, made by some manufacturers.

277. **The Pans** are generally of brass and frequently nickel-plated. Glass pans are also used. Heavily nickel-plated or silver-plated pans are the most useful. Moveable pans are always to be preferred. They should be reversed daily.

Watch crystals are useful accessories for weighing certain chemicals.

278. **Hand Scales** are lever balances without fixed support. The support for the knife edges is so constructed that it can be conveniently held by the hand, and the pans are suspended by silk cords or chains. The pans are commonly made of horn, but sometimes of metal.

Hand scales with horn pans of one, two, three and four inches diameter are very useful in pharmacy.

279. There should be at hand in every pharmaceutical establishment several balances differing in strength and delicacy. The practice of weighing large quantities in balances constructed so as to indicate minute differences in weight leads to the serious injury if not the virtual destruction of the instrument. On the other hand the comparatively coarse construction of balances intended for heavier loads renders them unfit for delicate operations.

280. The largest balances ("counter scales") needed by a pharmacist, to be used for quantities from one ounce up to twenty-five pounds, should turn with four or five grains when fully loaded. The next, to be used for quantities of from thirty grains to one or two ounces (sometimes called "dispensing scales") should be sensitive with one-half grain. The third balance (usually termed "prescription scales") should be sensitive enough to permit the weighing of one-twentieth of a grain (or, at least, of five milligrams) with perfect accuracy, and must not be used for larger quantities than thirty grains.

281. **Preservation.**—Balances must be protected from moisture, dust and corrosive gases. To this end they are generally provided with cases so made as to admit of the use of the instrument without removal. These cases are as a rule made of light mahogany frames, containing glass on the top and four sides to insure sufficient light. When the balance is not being used the case must be closed.

The pans must be kept scrupulously clean. They should be wiped gently with a soft piece of chamois skin immediately after using.

282. A good balance must not be subjected to unnecessary moving about; it should have a fixed place, and the table, stand or counter upon which it rests should be sufficiently heavy and firm to be unmoved by heavy shocks. The position of the balance should further be perfectly true by the spirit level. Delicate balances are usually supplied with cases having "set screws" in the four corners.

WEIGHTS.

283. **Weights** are pieces of metal or other materials of such size as to weigh simple multiples or aliquot parts of the established units. They are adjusted to correspond with the legal standard prototypes, or with exact copies of these standards.

284. **Materials Used.**—Large weights are ordinarily made of iron.

The most common material for smaller weights is brass.

Nickel-plated brass weights are the best for sets of from 1 kilogram to 1 Gram, or 2 lbs. to 1/8 oz.

Small weights for pharmacal and chemical purposes are best made of platinum and aluminium (when the size is below 1 Gram or 16 grains).

285. **Iron** weights must be painted or varnished to prevent rust.

286. **Brass** weights easily corrode and require frequent scouring, which soon reduces their value by abrasion.

287. **Silver** is rather soft for weights.

288. Platinum is exceedingly hard and moreover resists acids and heat. Platinum weights, therefore, can be readily

and thoroughly cleaned by washing them, then dipping them in strong hydrochloric acid, then in water, then in alcohol, and finally heating them a moment in the flame of the spirit lamp or of the Bunsen burner.

289. **Aluminium** is also very hard, and as this metal is very light small weights when made of aluminium are much larger than brass or platinum weights.

290. **Forms.** Metric weights and avoirdupois weights are usually cylindrical; but avoirdupois weights are also made in the form of truncated cones; the smaller resting in a shallow circular depression on the upper surface of the larger. Troy weights are generally cup-shaped, one fitting within the other to form a so-called "nest." But the forms vary greatly. Some ounce weights are cubical; drachm weights are sometimes coin shaped, etc.

Grain weights are made of sheet metal cut into square pieces, or of wire bent into angles, triangles, squares, etc.

291. **Denominations.**—The denomination of each weight is or should be legibly stamped upon it. Ordinarily this is done simply by common numerals; but sometimes a sign, symbol or abbreviation of the term used to designate the unit to which the numerals refer is also added. All weights should bear such a sign or abbreviation.

The avoirdupois ounce and the troy ounce may well be mistaken one for the other unless the inscriptions clearly distinguish them, and the same observation applies to many of the smaller metric weights and weights of the apothecaries' system.

When wire is used for grain weights the sides of the figures indicate the value. Thus a five-sided figure is a five-grain weight, a square weighs four grains, a triangle three grains, an angle (a wire bent only once) is a two grain weight, and a straight piece of wire weighs one grain if of the same calibre as the larger grain weights, but only half a grain if of smaller calibre.

Grain weights of sheet brass are often stamped simply by dots, the number of dots indicating the number of grains.

292. An abundant supply of accurate weights is required in a busy pharmacy.

They should be assorted according to size, and the small weights (from $\frac{1}{16}$ grain up to 1 grain, and from 4 milligrams up to 10 centigrams) should always be kept in a separate box.

Larger weights—from 1 to 60 grains, and from 5 centigrams to 5 Grams—are conveniently kept in a small drawer in the balance case, but this drawer must be kept scrupulously clean, and should contain nothing else but the weights and the pincets used in handling them.

Still larger weights are best kept in blocks of wood.

293. Small weights must not be handled with the fingers, but with pincets.

294. Complete sets of metric weights are now considered as part of the necessary furniture of a pharmacy. Such sets cost but little, and the most thorough method of becoming familiar with the metric system is to actually handle the weights and measures of that system.

295. All weights require to be verified before being used, and, moreover, are to be kept constantly clean and should be frequently re-examined.

296. Verification.—Balance the larger weights against a corresponding sum of smaller ones, removing, substituting, and transposing them in turn.

Platinum weights are scarcely at all liable to abrasion, and thereford remain accurate a very long time, *if kept clean.*

WEIGHING.

297. Accurate Weighing requires not only a good balance and true weights but deliberate care. It cannot be performed hastily.

It is necessary first to see that the instrument is in good order as to the perfect equilibrium and freedom of oscillation of the beam. Should the beam oscillate with difficulty, or "stick," this may perhaps be obviated in most cases by a gentle tap.

298. **Overloading** should never be indulged in. It not only damages the balance but vitiates accuracy. Improper loads sometimes cause the balance to "set," the oscillations ceasing and the beam remaining stationary in a horizontal position, but losing its equilibrium by the slightest impulse, which causes either arm to descend with an accelerated force until arrested by some interposing obstacle.

299. **True and Apparent Weight.**—The true weight of a body is its weight *in vacuo*. The apparent weight is its weight in air under the ordinary conditions of atmospheric pressure, humidity, and temperature. The apparent weight of a body weighed in any medium, as air or water, is less than its true weight, the difference being the weight of the air or water displaced by the body itself less the weight of the air or water displaced by the weights used.

All the ordinary operations of weighing, therefore, as carried on in practical pharmacy, give only the apparent weights of the substances weighed; and for pharmacal purposes the apparent weight is the only weight to be considered.

300. **The Load** should be put in the pan to the right, the weights being placed in the left pan. Both the weights and the substances weighed should be placed as nearly in the center of the pan as practicable. The object of using "cup weights" is to permit their being placed within each other in the center of the pan.

The loads must be placed upon the pan deliberately and carefully—not suddenly.

301. If the substance to be weighed is a powder, and the quantity small, it is put on the pan from the end of a spatula,

the handle of the spatula being held under the palm of the hand between the thumb and great finger, so that the blade can be gently tapped by the free index finger. The powder then falls lightly and in such small increments that the full amount can be readily put on the pan without adding the slightest excess.

302. When the substance to be weighed is one liable to adhere to the pan, or to soil or corrode it, a watch crystal may with advantage be placed in the pan to receive the substance. In that case another watch crystal of exactly the same weight is to be placed in the opposite pan, or the equilibrium restored by tareing.

Stout glazed paper may also be used for the same purpose; it is folded double, and two equal pieces are then cut with the scissors. Tearing pieces of paper to be used for this purpose is bad practice. Moist extracts, deliquescent salts, carbolic acid, and similarly moist substances, in small quantities, are not to be weighed in contact with the pan.

303. Tare.—The empty vehicles, to contain substances to be weighed, must of course be weighed separately before the "net weight" of the contents can be ascertained. The weight of the vehicle—whether a hogshead, carboy, bag, beaker, bottle, capsule or test tube—is called the "tare"; the total weight of the vehicle and contents together is called "gross weight," and the "net weight" is the gross weight minus the tare.

304. The Pharmacopæia and other working formularies frequently refer to "tared capsules" and other "tared" vessels. By this is meant a capsule or vessel the weight of which is known and recorded. When the tare of a vessel is taken for laboratory purposes, it should be taken with weights and a memorandum made of the result. Capsules ("evaporating dishes") which are in frequent use ought to have their tare legibly marked on the outside with some sharp instrument, in order to obviate the necessity of repeating the operation each time they are used.

305. **Counterpoise.**—In most cases where liquids are to be weighed it is not necessary to take the tare of the vessel by weight. It is generally sufficient to restore equilibrium by any convenient "counterpoise." Specific gravity bottles are often accompanied by a brass counterpoise, which is simply a piece of brass in the form of a weight, which exactly balances the empty bottle.

Some balances are provided with special side beams with a counterpoise sliding on a scale indicating the exact weight.

Fine shot and perfectly clean coarse sand are very useful for counterpoise. Two cups of horn, or of tinned iron, one filled with very fine shot, will answer this purpose admirably. The empty capsule, bottle or beaker being placed on one pan, equilibrium is nearly restored by the empty cup and some weights and finally the equipoise is completed by gradually pouring shot into the cup until the object is accomplished.

306. When several different liquids are to be weighed one after another into the same bottle or other vessel each liquid must be added very cautiously, as the balance does not turn until very nearly the entire quantity has been added, hence there is danger of pouring in an excess unless very great care is exercised.

MEASURES.

307. Vessels for measuring volume are called measures of capacity, but the common designation is simply the word "measures."

308. Large measures, as those for measuring bushels, pecks and gallons, are so constructed as to hold the proper quantity when full to the brim, less quantities being measured by smaller measures. They are made of wood, tinned iron, copper, brass, block tin, etc.

309. Smaller measuring vessels, such as pharmacists use, are graduated with appropriate scales.

Graduated measures for the use of apothecaries are extensively used in all countries; but fluid measures are used for dispensing purposes only in English-speaking countries. Hence we find that the apothecaries' measures used in Germany, France, Russia, Sweden, etc., are limited almost entirely to such large sizes as liters, half-liters, etc., and that they are generally made of porcelain or of block tin and provided with handles. Their chief use is to receive and measure colatures such as infusions and decoctions.

In English-speaking countries, however, graduated measures for pharmacal uses are made of glass, from 1 liter down to the 5 Cubic-centimeter graduate, or from a quart down to the "minim graduate," and surprisingly accurate "graduates" of this description are readily obtained in America and in England.

310. **The Forms** of graduated measures vary greatly; the larger sizes are usually straight cylinders, while the ordinary glass graduates are conical. The tall conical graduates, widening gradually from bottom to brim, are to be preferred. They are provided with lips. A well made graduate must stand straight when resting on its base.

311. **The Scales** on graduated glass vessels are usually engraved or etched. Those with the same scale marked on opposite sides, or with the markings of the scale encircling the body of the graduate are capable of more accurate and rapid work. Graduates with a metric scale on one side and a scale of American or English fluid measures on the other should not be used, because their use frequently leads to gross errors.

312. Graduated glass ware is made to discharge—not to hold—the quantities indicated on the scales, respectively, due allowance being made for the small quantity of water retained on the inner surface after emptying.

The best glass graduates are made by hand, one at a time, water being weighed into the vessel and the marks of the scale engraved to coincide with the level of the liquid. Thus these

measures of capacity are derived from weight. While this is the most accurate method, errors would naturally result in its application unless all the necessary conditions affecting the ratio of weight to volume are carefully observed, and corrections duly made for any material deviations from the normal conditions to which the accepted ratio is applicable. The temperature of the air and of the water, the atmospheric pressure and humidity, the weight of the air displaced by the water and the weights, the expansion of the vessel itself, etc., all these conditions affect the result more or less, and correction is usually made for these causes of error as far as deemed necessary, according to the uses for which the graduated vessels are intended.

313. Among the graduated glass ware required in a well equipped pharmaceutical establishment may be mentioned: Complete sets of pharmacal graduates, liter and half-liter flasks marked on the neck, graduated cylinders and burettes, pycnometers, hydrometers, and graduated pipettes.

314. The pharmacal graduated glass measures should include metric measures as well as those of the U. S. apothecaries' system. Among the most useful sizes of metric graduates are those of 25, 50, 100 300 and 500 Cubic-centimeters.

315. **The Verification** of graduates is best accomplished by means of the balance. One Cubic-centimeter of distilled water at 62° F., weighed in air, weighs under the ordinary atmospheric conditions, 998.43 milligrams; under the same conditions, one cubic-inch of water weighs 252.488 grains, one U. S. fluidounce weighs 455.663 grains, and one Imperial fluidounce weighs 437.5 grains.

MEASURING.

The proper manner of holding the graduate (its base
:d between the thumb and the first two fingers of
·hilst the stopper of the bottle is held by the
must be learned by actual practice. The

graduate must be raised to a level with the eye to enable the accurate reading of the scale. The bottle from which the liquid is poured should be held so that the label is on the upper side.

317. **Capillarity** causes all liquids capable of wetting the sides of the vessel to form a concave surface, whilst all liquids which do not adhere to the sides (as mercury) form a convex surface in the graduate. Hence the true level, which must be compared with the scale, lies between the height of the center and that of the periphery of the surface of the liquid.

318. Small quantities should not be measured in very large measuring vessels, where accuracy is requisite.

319. Measuring as well as weighing must be done with deliberate care, in order that due accuracy may be possible.

320. Thick, adhesive liquids are preferably weighed instead of measured, and then directly put into the bottle in which they are to be dispensed or used.

321. When several liquids are to be measured, one added to the other in the same graduate, especial care, of course, becomes necessary to prevent that an excess of either be poured into the mixture, as it cannot be again removed.

322. **Approximate Measures.**—The fact that liquid medicines must necessarily be administered in measured doses has led to the adoption of convenient but variable domestic measures frequently referred to in physicians' prescriptions. These measures are: the teacupful, wineglassful, tablespoonful, dessertspoonful, teaspoonful and the drop. That these several ready made measures are all quite as variable in size as they are convenient goes without saying. The following values have been arbitrarily assigned to them, viz.: A teacupful is regarded as about equal to four fluidounces; a wineglassful to two fluidounces; a tablespoonful to one-half fluidounce; a dessertspoonful to two fluidrachms; a teaspoonful to one fluidrachm; and one drop to about one minim. Not one of these

values is nearly correct. It is impossible to assign an average value to either of these measures; all that can be done is to state the capacity of *the most common* sizes of spoons at this time, which are probably about as follows:

A tablespoonful	=	f℥v, or 20 C.c.
A dessertspoonful	=	f℥iiss, or 10 C.c.
A teaspoonful	=	♏LXXX, or 5 C.c.

323. **The Drop** varies in size according to the liquid and the mode of dropping.

An ordinary dropping tube or pipette, such as is used by ophthalmologists, delivers drops of water equal to about one-half U. S. minim each.

324. Tables of the sizes of drops, or of the number of drops to each fluidrachm of different liquids, are to be found in many works. They show wide discrepancies, according to the size and form of the rod, lip, stopper, or other surface from which the drops fell when counted. Thus, according to Mr. Alsop, it required only 24 drops of diluted sulphuric acid to make one fluidrachm when dropped from a large bottle, but 84 when dropped out of a small one.

As such tables are of little or no practical value we omit giving any.

SPECIFIC WEIGHT.

325. **Bodies** are the things occupying space, possessing weight, and perceptible to our physical senses.

326. All bodies in nature possess volume, matter and density, each essential to their being.

327. By **Matter** we understand the *weighable* without regard to *space.*

328. By **Volume** we mean the space occupied by a certain amount of matter.

The length, breadth and height or thickness of a body, together indicate the extension, and the measure of its extension in all directions is its volume.

329. By **Density** is meant the amount of matter contained in a given volume of any body.

Of two bodies having the same volume, the one containing the greater amount of matter has, therefore, the greater density.

Of two bodies each containing the same amount of matter, the one having the greater density has necessarily the smaller volume.

330. The **Mass** of a body is the amount of matter it contains without regard to its volume.

When two bodies are of like density, their relative masses correspond with the relative volumes.

331. When equal volumes of different substances are weighed we nearly always find that one is heavier than another. This indicates their different densities.

The density of mercury being greater than that of water it follows that one Cubic-centimeter of mercury is heavier than one Cubic-centimeter of water.

332. **Weight** is the predominating gravity of terrestrial bodies towards the earth, without regard to volume; but the relative gravitating force of some one substance as compared with that of a like volume of some other substance is said to be its **specific weight.**

Thus *density* is nearly synonymous with *specific weight.*

333. When we say that one piece of iron is heavier than another piece of iron, that a pound is lighter than a kilogram, or that a cubic inch of water weighs more than a milliliter of the same liquid, we are only taking into account their **absolute weight,** for we are comparing different volumes with the obvious inference in view that the variance in weight is accounted for by that fact.

When, however, we speak of iron being heavier than chalk, or say that ether is lighter than chloroform, it is always understood that the comparison refers to equal volumes, and the weights referred to in this case are the *specific* weights proper to these substances, respectively.

334. When two or more substances are intimately mixed with each other—as in solutions, mixtures of liquids or of fats, alloys of metals, etc.—the specific weight of the mixture may naturally be expected to differ from the specific weight of any one of the ingredients. The proportions in which the several substances are mixed also affect the specific weight of the compound or solution. Hence the practical use of specific weight r ascertaining the identity and purity of substances, and the ngth of acids and solutions.

True Specific Weight, or density, *in vacuo,* appar- rs an intimate relation to the chemical constitution of s.

336. **Law of Archimedes.**—A body suspended in any gas or liquid is buoyed up by a force equal to the weight of the medium displaced by it.

A piece of brass immersed in water contained in a tumbler does not exert the same amount of pressure on the bottom of the tumbler as it would if the water were not in it. If the bulk of the piece of brass be exactly one cubic inch, it will apparently lose a little over 252 grains in weight, that being the weight of the one cubic inch of water displaced by it.

A boat floating on the lake sinks down just far enough to displace an amount of water equal to its own weight.

A piece of wood forced down under the surface of water strives to re-ascend with a power equal to the difference between its own weight and the weight of an equal volume of water.

337. Solid bodies sink in liquids of less density; if the respective densities of the solid body and the liquid be equal, the solid floats about aimlessly anywhere in the liquid, but if the density of the liquid be greater than that of the solid the latter will float on the surface of the liquid.

338. Air apparently weighs nothing, if the attempt be made to weigh it in air; hydrogen seems to weigh less than nothing if we attempt to weigh it in air; cork appears to weigh less than nothing when weighed under water, and water weighed suspended in water seems without weight.

If a specific gravity bucket filled with water be first weighed in air and afterwards weighed immersed in water of the same temperature, the total weight it apparently loses in water exceeds the weight of the water contained in it by just the weight of the water displaced by the bucket. If, however, ice cold water be put in the bucket, and the filled bucket carefully weighed in water at the common temperature, the apparent loss of weight of the water will not quite equal the weight of the ice-water in the bucket.

339. **Apparent Specific Weight** is the specific weight observed under ordinary circumstances without making allowances for air displaced and for other influences which affect the result, but which do not cause deviations of sufficient magnitude to require correction, except in the exact determinations by physicists.

For ordinary chemical and pharmacal purposes the apparent specific weight is the one always referred to.

340. **The Standards of Comparison.**—In order that the densities of different substances may be conveniently and intelligently compared they are all referred to accepted standards. For liquids and solids the standard is the specific weight of water ; for gases it is the specific weight of air.

341. **Water** was chosen for the comparison of volume and weight, and as the connecting link between measures and weights, because it is universally distributed and easily obtainable in a pure state.

For these purposes water at its greatest density (at $+4.^{\circ}$ C., or $39.^{\circ}2$ F.) is generally chosen, because near that point a slight deviation of temperature causes no material discrepancy in the results.

Water at some fixed temperature is, therefore, the unit of comparison for the expression of specific weight of all solid and liquid substances.

342. **For gaseous substances,** however, air is the unit commonly referred to, though hydrogen is also used as a standard.

343. **Specific gravity** is the most common expression used to designate specific weight. And the universal meaning of the term specific gravity is : THE RATIO OF THE WEIGHT OF ANY SOLID OR LIQUID TO THE WEIGHT OF AN EQUAL VOLUME OF WATER ; or the ratio of the weight of any gaseous substance to the weight of an equal volume of air.

344. **The Specific Weight** (less appropriately termed "specific gravity") of a solid or liquid is, then, practically, that number which expresses how many times the weight of a given volume of water is contained in the weight of an equal volume of that solid or liquid; and the specific weight of a gas is expressed by the number of times the weight of a given volume of air is contained in the weight of an equal volume of that gas. Hence the specific weight of water is 1, and the specific weight of air is also 1.

345. **Temperature** materially affects the volume of substances, and hence also their specific weight. For this reason the degree of temperature at which the specific weight is or should be taken must be carefully observed. All substances, except water, invariably expand with an increase of temperature. Water reaches its maximum density at +4.° C. (39.°2F.), and expands with any change both below and above that temperature.

346. **Standard Temperature.**—Water at its maximum density (+4.° C., or 39.°2 F.) is the unit to which specific weight is referred on continental Europe. The specific gravities given in the tables of the U. S. Pharmacopœia in some cases refer to water at that temperature as unit, in others to water at 0.°C. In the Alcohol Table of that work water at 15.56°C (60.° F.) is referred to as unit. In several of these tables the standard temperature at which water is to be regarded as = 1 is not stated.

The U. S. Pharmacopœia should state in exact terms what constitutes the standard unit of comparison for specific weights. If it is to be water at +4.° C., that should be stated and all specific gravities should then be expressed with reference to that standard.

347. Our alcoholometers and other hydrometers, as well as the pycnometers we use, are, however, adjusted with reference to water at 15.56° C. and 15.° C. as the standards of comparison. Hence, the observed specific gravity of, for instance,

any acid, taken as directed in the Pharmacopœia, cannot agree with that given in the pharmacopœial table.

348. While the standard temperature is that temperature at which water is regarded as = 1, the specific weight of any liquid of any other temperature may be stated with reference to water at the standard temperature. Thus, having adopted 15.°6. C. as the standard temperature for the specific gravity of alcohol, the Pharmacopœia gives the specific weight of water at 15.6 C. in the alcohol table as 1.000, the specific weight of official alcohol at 15.°6 C. is given as 0.820 referred to water at 15.°6 C., and of official alcohol at 25.° C. as 0.812 also referred to water at 15.°6 C. as = 1.

But when the Pharmacopœia gives the specific weight of stronger ether as 0.725 at 15.° C., and as 0.716 at 25.° C., the numbers do not refer to water at either 15.° C. or at 25.° C., but to water at +4.° C. as the unit of comparison. Yet, there is nothing in the Pharmacopœia to call attention to these important facts.

349. The temperature at which the specific weight is to be observed—that is, the temperature of the liquid the specific weight of which is to be taken—is usually prescribed in the Pharmacopœias. That temperature is also called the "standard temperature;" but it is the standard temperature only when it coincides with that at which water is assumed to be = 1.

The British government prescribes 62.° F. as the temperature at which spirits are to be tried; the standard Imperial gallon is the volume of a given weight of water at that temperature, and the British Pharmacopœia also refers to it as the temperature at which specific weight is to be taken; but the specific weights actually stated in the British Pharmacopœia do not refer to water at 62.° F. as unit.

In the United States the "standard temperature" prescribed by law for ascertaining the strength of spirits by the alcoholometer is 60.° F., and this was also the temperature at which specific gravities were ordered to be taken by the Pharmaco-

pœia of 1870. But the specific gravities given in that Pharmacopœia are not based upon water at 60.° F. as unit.

In the Pharmacopœia of the United States specific weight is to be taken at 15.° C., and it is expressly stated that "whenever specific gravity is mentioned in the Pharmacopœia, without reference to temperature, it is to be understood to refer to a temperature of 15.° C." But this only means that the liquid of which the specific gravity is thus given has that specific gravity only at that temperature; and it does not mean that the specific gravity mentioned is based on a comparison with water at 15° C.

350. As all practical pharmacal operations are carried on at common room temperatures, and as it is easier to warm a cool liquid up to the temperature of the room, or slightly above that, than it is to cool a warmer liquid down to + 4.° C. or even to 15.° C., it seems worth while to consider whether we ought not to adopt a higher standard temperature for pharmacopœial specific weights. The temperatures of 20.° C and 25.° C. (68. °F and 77.° F.) deserve to be considered in this connection as well as 15.° C. (59.° F.). Probably 22.° C. (71.°6 F.) would be the most suitable temperature for this purpose.

In any event the temperature of the water referred to as unit, the temperature at which specific weights are to be taken, and the temperature understood to be that at which the liquids have the specific weights mentioned in the Pharmacopœia, should be one and the same, and should be as nearly as possible the average room temperature at which we ordinarily do all our work. And the hydrometers and pycnometers we use should be constructed with reference to the same standard temperature.

351. In several instances the U. S. Pharmacopœia (1880) gives the specific gravities at two different temperatures—at 15. C. and 25.° C. This is done in cases where the expansion by heat is greater than usual and not regular, and for the pur-

pose of calling attention to that expansion, and that one may be a check upon the other.

352. It is evident, from what has been said, that the numerical expressions used to indicate specific weight should be accompanied by a statement of the temperature of the substance when its specific weight was observed, as well as of the temperature of the water referred to as a standard of comparison, otherwise they are not sufficiently explicit. The specific weight of water at +4.° C., referred to water at the same temperature as unit is 1; but the specific weight of water at +4.° C. referred to water at + 16.°66 C. as unit is 1.001; the specific weight of water at 16.°66 C. in air referred to water at +4.° C. *in vacuo*, as unit, is 0.99779, whereas the specific weight of water at 16.°66 C. referred to water at the same temperature as unit is 1, if both are considered as *in vacuo* or as in air; but water at 16.°66 C. referred to water at + 4.° C. as unit, both *in vacuo*, has the specific weight 0.9989.

353. **Barometric Pressure** also affects the ratio of volume to weight, and hence the true density *in vacuo* differs from the apparent specific weight in air, and the apparent specific weight at the **stardard atmospheric pressure**—barometer at 30 inches—differs from that found under other barometric conditions.

354. The rule for finding the specific weight of any solid or liquid by calculation is: *divide the weight of a given volume of the substance by the weight of an equal volume of water;* the quotient is the specific weight sought.

355. The most direct method of finding the specific weight of a substance, therefore, is: to weigh a given volume of it, then weigh an equal volume of water, and finally divide the weight of the substance by the weight of the water, both weighings being done at the standard temperature and pressure.

This can be conveniently done only in the case of liquids. For instance, a two-ounce bottle is counterpoised on the scales, filled with glycerin, and the weight of the latter ascertained;

then the bottle is emptied, carefully rinsed, and filled with distilled water, and the weight of this also obtained. It now remains only to divide the weight of the glycerin with the weight of the water.

356. **Pycnometers, or Specific Gravity Bottles** are manufactured and sold by instrument makers, which, when accurately finished, possess great advantages. They are made to hold exactly 1,000 grains (sometimes 500 or only 100 grains) of distilled water at the standard temperature, when completely filled. The neck is supplied with a close-fitting ground stopper, perforated by a vertical capillary canal. Such a bottle is always accompanied by a weight, which exactly counterpoises it.

When this bottle is filled with a liquid, the specific gravity of which is to be ascertained, and placed upon the pan against the counterpoise on the opposite side, the number of grains necessary to restore equillibrium, of course, expresses the weight of the liquid in the bottle, and this weight divided by the quantity of water by weight that the bottle is capable of holding (1,000, 500 or 100 grains) will be the specific gravity sought. Suppose the liquid thus weighed in a thousand grain bottle should be found equal to 800 grains, then

$$\frac{800}{1000} = 0.800$$

is the specific gravity of that liquid.

357. In common with balances, weights and measures, specific gravity bottles require to be verified before being used. This is done as follows: The bottle and stopper being well cleaned and dried, are brought to the standard temperature by being put for an hour in a place where the thermometer indicates that temperature. It is then counterpoised; the counterpoise is correct, if, being of the same temperature as the bottle, it produces equilibrium when opposed to the latter on the scales, and if it does not this fault must be remedied before proceeding further. When perfect equilibrium has been at-

tained the bottle is filled with pure water at standard temperature, and the increase of weight ascertained. This increase must coincide with the quantity of water the bottle should contain (1000. gm or 100 grains.)

358. Specific gravity bottles of fair accuracy may be made by the pharmacist himself. All that is necessary is to select a small well-stoppered bottle, clean it, weigh it and make a note of the exact counterpoise for future reference; then the quantity by weight of pure water, at the standard temperature, that this bottle is capable of holding is ascertained and also written down. Both these quantities may be written on a slip of paper to be kept with the bottle. The latter weight will then be the divisor; the dividend is the weight of this bottle-ful of any liquid the specific weight of which is sought; and the quotient is the specific weight of this liquid.

359. The pycnometer must be thoroughly cleaned each time before and after being used, and ought not to be put away after using until well dried. When about to be used it should be rinsed out once or twice with a little of the liquid which is to be tested. After using, it may be washed out with water, alcohol, ether or chloroform, an appropriate selection being made according to the character of the liquid to be removed. All traces of the solvent used for cleaning the specific gravity bottle must be gotten rid of by evaporation, or by a current of dry air blown into the instrument from a bellows, or by suction through a glass tube inserted in the warmed bottle.

360. The Pharmacopœia says that "the specific gravity of liquids should be ascertained, if accuracy is required, by means of a specific gravity bottle of suitable capacity at a definite temperature. The specific gravity of alcohol or of any mixture of alcohol and water may, however, also be ascertained by means of an accurate hydrometer, preferably that prescribed by the United States Government for the use of internal revenue and custom house officers."

(See paragraphs 347–350.)

361. **Hydrostatic Balance.**—Any upright lever balance, with the beam supported on a tall fixed pillar, and the pans suspended from the extremities of the arms, can be made to serve the purpose of a "hydrostatic balance"—a balance for the determination of the specific weights of solids by weighing them immersed in liquids. All that is necessary is to substitute a pan with a short stirrup on the right side in place of the mate to the one on the left, the pan itself to have a small hook in the center of its under side for the suspension of the bodies to be weighed. The object of shortening the stirrup is, of course, simply to leave ample space for the convenient suspension (by silk thread or wire) of the bodies to be weighed while immersed in the liquid contained in a vessel placed on the table immediately under the pan.

362. The specific gravity of a solid heavier than water is readily ascertained by weighing it first in air and then suspended in water. The loss in weight which it sustains being the weight of an equal volume of water, the subsequent calculation is easily made.

Ex.: The solid weighs in the air 5 Grams, and suspended in water 4 Grams; consequently an equal volume of water weighs 5−4=1 Gram, and the specific weight of the solid is $\frac{5}{1}=5$.

363. When the substance is lighter than water it may be forced down by means of a sufficiently heavy body attached to it.

Ex.: A piece of cork weighs in the air 1.464 Grams; a piece of metal used for the purpose of forcing the cork down under the water's surface loses in water 2.2 Grams; the metal and cork together lose (in the water) 8.3 Grams; consequently the cork alone must lose 6.1, which is the weight of its own volume of water, and

$$\frac{1.464}{6.100}=0.24$$

is the specific weight of the cork.

364. If a glass bulb, or any other solid body, unaffected by the liquids, be weighed first in one liquid and then in another, a difference in the loss of weight, sustained by it in these two

trials, will be noticed if the densities of the liquids vary. As the loss in each case is equal to the weight of an equal volume of the liquid, the specific weight of liquids may be arrived at also in this way, the loss of weight in water being one of the factors.

365. The substance to be tried must be weighed immersed in some liquid which does not affect it, and the specific weight of which is already ascertained. Alcohol, oil of turpentine or olive oil may be used for water-soluble substances. The weight of the substance in air (a); the loss it sustains in the liquid, or, which is the same, the weight of an equal volume of the liquid used as a medium (b); and the specific weight of the latter (c), will enable us to arrive at the desired result (x), as follows:

$$x = a \div \frac{b}{c}$$

366. For determining the specific weight of powders, or substances in small particles, the following method is applicable, provided the substance is heavier than water and insoluble in it:

The powder is weighed in air; it is then introduced into the pycnometer and the latter filled with water, after which the total contents are weighed. By deducting the weight of the powder (a) from the aggregate weight (b) of the water and powder together, we obtain the weight (c) of the water contained in the bottle; this, deducted from the weight (d) of the quantity of water which the pycnometer is capable of holding when filled with that liquid alone, will leave the weight (e) of the water displaced by the powder; and this weight is our divisor, the dividend is the weight of the powder, and the quotient will be the specific weight sought (f) :—

$$f = \frac{a}{d-c}.$$

367. **Specific Gravity Buckets** are little glass buckets which can be suspended from the bottom of the pan of a balance for the purpose of facilitating the weighing of insoluble substances in powder or in small fragments, immersed in liquids. The weight (a) of the bucket in air is ascertained; its weight (b) when suspended in the liquid is next found; b deducted from a gives the weight (c) of the liquid displaced by the bucket. Then the weight (d) of the substance is taken, after which it is placed in the bucket, and the bucket with the substance in it is then weighed immersed in the liquid. The aggregate weight (e) of the two in the liquid is then deducted from the sum of their weights ($a+d$) in air in order to arrive at their joint loss of weight (f) when suspended in the liquid. From this, the weight (f) of the liquid displaced by the bucket and the substance together, we then deduct the weight (c) of the liquid displaced by the bucket alone, the remainder being the weight (g) of the liquid displaced by the substance itself. By dividing d by g we then obtain the specific weight (h) of the substance with reference to the liquid in which it was weighed. If the liquid was water of standard temperature further calculations are unnecessary; if some other liquid was used then the specific weight (h) found must be multiplied by the specific weight (i) of that liquid in order to get the specific weight (k) of the substance with reference to water as unit.

$a-b=c$=weight of liquid displaced by bucket.

$a+d-e=f$=weight of liquid displaced by bucket and substance together.

$f-c=g$=weight of liquid displaced by the substance alone.

$\frac{d}{g}=h$=specific weight of the substance as compared with the liquid=1.

$h \times i=k$=specific weight of the substance as compared with water=1.

368. To ascertain the weight of a cubic inch of water a similar method is pursued. A heavy body, the volume of which is exactly one cubic inch is weighed first in air and next suspended in water; the difference in the result of the two weights represents the weight of one cubic inch of water.

369. **Specific Gravity Beads** are sealed glass bulbs of various specific weights, which are ascertained and marked on them. These beads will float at any point throughout a liquid having the same specific weight.

370. On the same principle that governs the use of specific gravity beads, it is entirely practicable to prepare liquid media in which fragments of solid substances remain in equilibrium at any point below the surface, which will always be the case when the specific weight of the medium or liquid is identical with that of the substance floating in it. The liquid must of course be one by which the solid substance is unaffected.

371. Hager's method of taking the specific weight of fats and similar substances consists in diluting alcohol or water of ammonia with water until of the same density as the substances, or in other words, until the fats remain floating in any part of the liquid, after which the specific weight of the latter is taken by means of a hydrometer.

372. **The Areometer, or Hydrometer** as it is commonly called, consists of a glass tube, the lower end of which is blown into the shape of a bulb, immediately above which the tube is cylindrically somewhat expanded for a short distance. The bulb is filled with either mercury or small shot, so as to bring the center of gravity of the whole instrument sufficiently far down to cause it to take a vertical position when plunged into a liquid, and also that it may sink down to that point on the tube at which one end of the scale commences.

373. **Direct Specific Gravity Areometers** indicate
ic weight directly by the scale. The general areometers
kind have the unit, or the specific weight of water, at the
temperature, near the middle of the stem or scale.
ter will sink below that point in liquids lighter than
ll rise with that point above the surface in a

o be accurately graduated with a fairly com-
ral areometers will be too long to be con-

venient, hence, the best plan is to use one areometer for heavy and another for light liquids.

Areometers for light liquids have the unit at the bottom of the stem; for heavy liquids the unit mark is at the top of the areometer stem.

374. **Special Areometers** adapted to particular liquids are quite common and very useful. Alcoholometers, saccharometers, lactometers, urinometers, etc., belong to this class.

As the range of the specific weights of each is limited, the scales on these special areometers can be constructed with considerable spaces for very small numerical intervals, which of course insures greater accuracy in the observations taken with them.

375. Arbitrary scales of "degrees" and "percentage" are used with several areometers. Such scales may be convenient for some special purposes, but as a rule they are unscientific and confusing. Baumé's hydrometer is of this kind, and is in common use in the arts and manufactures. Alcoholometers indicate the "degrees *proof*," or the percentage, or both.

376. **Baumé's Hydrometer** for liquids heavier than water is provided with a scale of arbitrary degrees. American manufacturers of acids and other chemicals use Baumé's hydrometer largely, and the strengths of acids, ammonia, etc., are generally stated on price-lists and containers in degrees Baumé. Thus, the water of ammonia of the U. S. Pharmacopœia, containing 10 per cent. ammonia gas, is marked "16.° B.," the strong "C. P.," nitric acid, or pharmacopœial nitric acid of 1.42 sp. gr., is marked 43° B., etc.

377. **Baumé's Scales.** Originally the two Baumé's scales were constructed as follows:

For the *acidometer*, or hydrometer used for liquids heavier than water, as acids and saccharine solutions, the zero was that point to which the instrument sank in water at 15.° C., and was

at the upper end of the scale on the hydrometer stem. The point to which the hydrometer sank when plunged into a solution of 15 parts dry table salt in 85 parts water, temperature at 15.° C., was then marked; the distance between these two points was then divided into 15 equal parts called "degrees," and the scale extended by marking additional degrees at equal intervals as far as requisite.

For the *spirit hydrometer*, used for liquids lighter than water, as ether, alcohol, ammonia water, etc., the point to which the instrument sank in pure water at 15.° C., was first taken, and then the point to which it descended in a solution of 10 parts dry table salt in 90 parts of water, temperature also at 15.° C. The interval between these two points was divided into 10 equal degrees, pure water being taken as 10.°, and the scale continued by adding additional degrees from 10.° upwards.

These methods of constructing the scales were so clumsy that various propositions have been made from time to time for their improvement. A most acceptable improvement would be to abolish them. The proper hydrometers for all liquids are those indicating specific gravities, and these, in addition to an alcoholometer indicating per cent. by weight, are all we need.

378. The Baumé hydrometer for liquids heavier than water, now used in the United States, is so constructed that its zero coincides with the point to which the instrument sinks in water at 15.55° C. (60.° F.), and 66.° corresponds with the point to which it sinks in concentrated sulphuric acid of 1.8354 at 15.55° C.

379. Among the obvious defects of Baumé's hydrometers may be mentioned the fact that the degrees above 9 are to be found on both scales, and that it is necessary to know which scale the degree refers to before we are able to understand its import, and that, as a rule, we find it necessary to refer to the specific gravity tables for interpretations before we can com-

pare the results with the most accurate determinations of density available to us, all of which are expressed in the form of specific weight.

Thus, 16.° B., by the scale of liquids heavier than water corresponds to 1.124 sp. gr., while 16.° B. by the scale for liquids lighter than water means a specific weight of 0.9589.

380. Rules for reducing degrees Baumé to specific weight and *vice versa:*

For liquids heavier than water.

$$\frac{145.}{145-B.^{\circ}} = \text{Specific weight;} \quad 145 - \frac{145}{\text{sp. w.}} = \text{Baumé degree.}$$

For liquids lighter than water.

$$\frac{140}{130+B.^{\circ}} = \text{Specific weight} \quad \frac{140}{\text{sp. w.}} - 130 = \text{Baumé degree.}$$

RELATIONS OF BAUME'S HYDROMETER SCALES TO SPECIFIC WEIGHTS.

After Henry Pemberton, 1852.

For liquids heavier than water.

At 15.°55 C. (60.° F.).

Degree B.	Specific Gravity.	Degree B.	Specific Gravity.	Degree B.	Specific Gravity.	Degree B.	Specific Gravity.	Degree B.	Specific Gravity.
0	1.0000								
1	1.0069	16	1.1240	31	1.2719	46	1.4646	61	1.7261
2	1.0139	17	1.1328	32	1.2831	47	1.4795	62	1.7469
3	1.0211	18	1.1417	33	1.2946	48	1.4949	63	1.7682
4	1.0283	19	1.1507	34	1.3063	49	1.5104	64	1.7901
5	1.0357	20	1.1600	35	1.3181	50	1.5263	65	1.8125
6	1.0431	21	1.1693	36	1.3302	51	1.5425	66	1.8354
7	1.0507	22	1.1788	37	1.3425	52	1.5591	67	1.8589
8	1.0583	23	1.1885	38	1.3551	53	1.5760	68	1.8831
9	1.0661	24	1.1983	39	1.3679	54	1.5934	69	1.9079
10	1.0740	25	1.2083	40	1.3809	55	1.6111	70	1.9333
11	1.0820	26	1.2184	41	1.3942	56	1.6292	71	1.9595
12	1.0902	27	1.2288	42	1.4077	57	1.6477	72	1.9863
13	1.0984	28	1.2393	43	1.4215	58	1.6666	73	2.0139
14	1.1068	29	1.2500	44	1.4356	59	1.6860	74	2.0422
15	1.1153	30	1.2608	45	1.4500	60	1.7058	75	2.0714

For Liquids Lighter than Water.

At 15.°55 C. (60.° F.).

Degree B.	Specific Gravity.	Degree B.	Specific Gravity.	Degree B.	Specific Gravity.	Degree B.	Specific Gravity.	Degree B.	Specific Gravity.
10	1.0000	25	0.9032	40	0.8235	55	0.7567	70	0.7000
11	0.9929	26	0.8974	41	0.8187	56	0.7526	71	0.6965
12	0.9859	27	0.8917	42	0.8137	57	0.7486	72	0.6930
13	0.9790	28	0.8860	43	0.8092	58	0.7446	73	0.6896
14	0.9722	29	0.8805	44	0.8045	59	0.7407	74	0.6863
15	0.9655	30	0.8750	45	0.8000	60	0.7368		
16	0.9589	31	0.8695	46	0.7954	61	0.7329		
17	0.9523	32	0.8641	47	0.7909	62	0.7290		
18	0.9459	33	0.8588	48	0.7865	63	0.7253		
19	0.9395	34	0.8536	49	0.7821	64	0.7216		
20	0.9333	35	0.8484	50	0.7777	65	0.7179		
21	0.9271	36	0.8433	51	0.7734	66	0.7142		
22	0.9210	37	0.8383	52	0.7692	67	0.7106		
23	0.9150	38	0.8333	53	0.7650	68	0.7070		
24	0.9090	39	0.8284	54	0.7608	69	0.7035		

381. **Alcoholometers.** Alcoholometers are hydrometers of special construction and scales for taking the strength of spirits.

The U. S. Custom House Alcoholometer is a hydrometer with Tralles' scale, zero being the point to which the instrument sinks in water at 15.55° C. (60.° F.), and 100 the point to which it sinks in absolute alcohol at the same temperature. Each degree between 0 and 100 indicates the per cent. absolute alcohol *by volume*. The same alcoholometer is used in Germany.

Gay-Lussac's alcoholometer is used in France. It is practically identical with Tralles' instrument, the only difference being that Gay-Lussac's scale is to be used at a temperature of 15.° C. (59.° F.), instead of at 15.55° C. (60.° F.)

The best alcoholometers, for pharmacal purposes at least, are those that indicate the percentage of absolute alcohol *by weight*, at a given temperature, and are provided with a thermometer inserted just above the bulb.

382. Corrections for expansion or contraction by higher or lower temperature than the stated standard are made as follows: If the standard temperature to which the instrument is adjusted be 15.° C. and the spirit is above that standard temperature at the time of observation, then 0.36 must be deducted from the indication for each degree, and if the spirit is below the standard temperature 0.36 for each degree of temperature must be added to the indication.

If the alcoholometer scale applies to 15.55° C., the correction to be made in the same way is 0.25.

383. The Urinometer is a small and delicate hydrometer with a scale divided into sixty equal degrees, the zero being the point to which the instrument sinks in pure water, and the actual specific weight being indicated by the other numbers added to 1,000, which is the number chosen to indicate the specific weight of water. Thus, if the instrument floats at 40.° of the scale, the specific weight of the urine is 1.040. Healthy urine ranges between 1.010 and 1.020, and this range is frequently marked on the scale by the letters "H. S.," meaning *healthy standard.* Diabetic urine ranges from 1.030 to 1.060, this range being marked accordingly Urinometers, with the necessary cylinders and thermometers, are sold in complete sets.

Specific gravity beads have been employed to a considerable extent for taking the specific weight of urine at the bedside, for which purpose they are specially adapted.

384. Cylinders of glass are necessary to contain the liquids to be tested by the areometers or hydrometers. These are provided with a flat base, and a rim or lip at the top to facilitate pouring. They are about 4 to 6 centimeters diameter and 30 to 50 centimeters high, according to the requirements in each case.

385. Use of Liter Flasks for taking the specific weight of liquids. An ordinary chemical flat-bottom flask of thin

glass, with long narrow neck, holding one kilo of water at a given standard temperature up to a line engraved around the neck, is of great value in practical pharmacy, not only as a means of verifying metric graduates, but also for taking the specific weight of many liquids of which large enough quantities are always conveniently at hand, as tinctures, fluid extracts, ether, alcohol, many solutions, etc. As the neck is very narrow in proportion to the volume of liquid contained in the flask there can be no material error on account of any failure of perfect coincidence of the surface of the liquid with the graduation mark. If the liquid is of proper temperature it is only necessary to fill the previously tared flask with it up to the line marked on the neck, and then to take its weight in Grams: this weight directly indicates the specific weight to three decimals.

The temperature prescribed by the U. S. Pharmacopœia being 15.° C., the liter flask should be graduated to hold, when filled to the mark, 1 kilogram of water, at that temperature.

Ex.: The liquid to be tested being at 15.° C., and its weight being 1,080 Grams, its specific weight is 1,080 at 15.° C. referred to water at the same temperature as unit.

386. To find the weight of any given volume of any liquid: Reduce the volume measure to Cubic-centimeters, and multiply by the specific weight; the product is the weight in Grams.

Or, reduce the volume measure to Imperial fluidounces and multiply by the specific weight; the product is the weight in avoirdupois ounces.

387. Another method of finding the weight of a certain bulk of any liquid is to multiply the number of weight units (of one kind) representing an equal volume of water by the specific weight of the liquid.

Ex.: To find the weight of 48 gallons oleic acid: As 48 gallons of water weighs 400 lbs., and the specific weight of oleic acid is 0.910; therefore the weight of 48 gallons of oleic acid is 400×0.910, or 364 lbs.

CONDENSED SPECIFIC GRAVITY TABLES.

The three following concise and practical tables of specific weights have been prepared for this work upon the author's request by Dr. A. B. Lyons, of Detroit.

In the sulphuric acid tables Dr. Lyons has used his own results instead of those of Kolb given in the U. S. Pharmacopœia, the differences in a portion of the tables being considerable.

The figures for alcohol are from Dr. Lyons' own observations, collated with those of Squibb, Gilpin, Fownes and others,

Table A will be of greater practical value to pharmacists than any others, because it gives the specific weights of the respective liquids at the mean temperature at which we work, and the specific weights stated refer to water at the same temperature as unit.

TABLE A.—SPECIFIC WEIGHTS OF ALCOHOL, ACIDS AND AMMONIA, AT 22° C.

Sp. gr. at 22.°C. (=71.6.° F.); Water at 22.° C.=1 0000.

Per cent.	Alcohol volume per cent.	Alcohol weight per cent.	Sulphuric Acid H_2SO_4	Nitric Acid HNO_3	Phosphoric Acid H_3PO_4	Acetic Acid $HC_2H_3O_2$	Hydrochloric Acid HCl.	Ammonia. NH_3	Per cent.
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0
1	.9984	.9980	1.0064	1.0056	1.0056	1.0014	1.0049	.9958	1
2	69	61	129	112	112	28	098	916	2
3	54	43	193	168	168	41	147	875	3
4	40	25	259	224	225	56	195	834	4
5	24	08	325	281	281	70	244	794	5
6	12	.9891	393	337	338	85	292	755	6
7	.9898	75	461	294	395	1.0100	341	715	7
8	84	60	530	451	454	14	390	676	8
9	72	46	599	500	513	27	438	638	9
10	59	31	669	556	572	41	487	600	01

Per cent.	Alcohol Volume per cent.	Alcohol Weight per cent.	Sulphuric Acid H_2SO_4	Nitric Acid HNO_3	Phosphoric Acid. H_3PO_4	Acetic Acid $HC_2H_3O_2$	Hydrochloric Acid HCl.	Ammonia NH_3	Per cent.
11	.9847	.9817	1.0739	1.0624	1.0632	1.0155	1.0535	.9562	11
12	36	04	810	682	693	68	584	525	12
13	24	.9790	881	741	753	81	633	489	13
14	12	76	953	800	814	95	682	454	14
15	01	63	1.1025	859	876	1.0208	731	419	15
16	.9790	49	098	919	938	21	780	385	16
17	79	35	171	978	1.1001	34	830	351	17
18	68	22	244	1.1048	064	48	879	318	18
19	56	08	318	098	127	61	929	286	19
20	45	.9694	392	159	191	74	978	253	20
21	34	80	467	220	256	87	1.1028	221	21
22	23	66	542	283	322	1.0300	078	190	22
23	11	52	618	346	388	12	128	158	23
24	.9699	37	695	409	455	24	178	127	24
25	88	22	773	472	523	36	228	096	25
26	76	07	852	535	592	48	279	065	26
27	63	.9592	930	600	661	59	330	034	27
28	51	76	1.2009	665	731	71	382	003	28
29	39	60	088	731	803	82	433	.8973	29
30	27	43	168	796	875	93	484	.8943	30
31	14	26	249	860	947	1.0404	534		31
32	01	08	331	925	1.2020	15	583		32
33	.9588	.9490	413	990	094	26	632		33
34	74	72	496	1.2055	169	37	680		34
35	60	54	579	120	244	48	728		35
36	46	35	662	185	319	58	775		36
37	31	16	746	251	395	68	822		37
38	16	.9396	831	316	472	78	867		38
39	00	76	916	382	549	88	913		39
40	.9484	55	1.3002	448	627	97	958		40
41	68	34	089	514	706	1.0506	1.2002		41
42	51	14	176	581	785	15	1.2045		42
43	34	.9293	264	648	866	24			43
44	16	72	353	715	947	33			44
45	.9398	51	443	782	1.3030	42			45
46	80	30	534	849	113	50			46
47	62	08	627	916	197	58			47
48	43	.9186	721	980	283	67			48
49	24	63	817	1.3044	369	75			49
50	04	41	914	106	457	83			50
51	.9285	18	1.4012	168	545	90			51
52	65	.9096	110	229	634	98			52
53	44	73	210	290	724	1.0605			53
54	23	51	310	347	816	12			54
55	02	28	410	401	908	18			55

Per cent.	Alcohol Volume. Per cent.	Alcohol Weight Per cent.	Sulphuric Acid. H_2SO_4.	Nitric Acid. HNO_3.	Phosphoric Acid. H_3PO_4.	Acetic Acid. $HC_2H_3O_2$.	Hydrochloric Acid. HCl.	Ammonia NH_3.	Per cent.
56	.9181	.9005	1.4511	1.3456	1.4001	1.0625			56
57	60	.8982	613	510	.095	31			57
58	38	60	716	565	190	37			58
59	16	37	819	617	286	42			59
60	.9093	14	923	669	383	48			60
61	70	.8891	1.5028	720	480	53			61
62	47	68	133	771	579	57			62
63	24	45	240	822	678	63			63
64	01	21	347	871	778	68			64
65	.8978	.8796	455	920	879	72			65
66	55	72	564	968	980	77			66
67	31	48	674	1.4016	1.5083	80			67
68	08	24	785	064	186	84			68
69	.8884	00	896	110	290	87			69
70	59	.8676	1.6007	152	395	91			70
71	34	52	118	192	501	94			71
72	08	27	229	230	608	97			72
73	.8781	03	340	267	716	99			73
74	54	.8579	452	302	825	1.0701			74
75	27	55	564	336	935	02			75
76	00	31	676	370	1.6046	02			76
77	.8673	07	789	403	158	03			77
78	45	.8482	901	436	271	03			78
79	18	58	1.7012	469	385	02			79
80	.8590	33	124	502	498	02			80
81	62	09	236	535	612	00			81
82	34	.8384	347	568	726	1 0699			82
83	06	59	457	600	841	97			83
84	.8477	33	564	633	957	94			84
85	47	08	668	666	1.7074	90			85
86	17	.8283	769	699		86			86
87	.8386	57	865	732		82			87
88	55	31	956	764		77			88
89	23	05	1.8036	797		70			89
90	.8291	.8178	107	830		62			90
91	58	51	167	865		54			91
92	24	24	217	899		45			92
93	.8188	.8097	257	934		35			93
94	51	69	289	969		22			94
95	13	41	316	1.5004		08			95
96	.8073	12	338	039		1.0592			96
97	32	.7982	350	074		72			97
98	.7988	52	360	109		50			98
99	42	22	365	146		1.0526			99
100	.7891	.7891	1.8345	1.5183					100

TABLE B.—SPECIFIC WEIGHT OF ALCOHOL AT 15° C.

Sp. gr. at 15.° C. (59.° F.), water at 15.° C.—1.000.

Per cent.	Alcohol. Volume per cent.		Alcohol. Weight per cent.		Per cent.	Alcohol Volume per cent.		Alcohol. Weight per cent.	
	Sp. gr	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.°C.		Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.
0	1.0000	.00014	1.0000	.00014					
1	.9985	14	.9982	14	41	.9507	62	.9377	70
2	71	15	64	15	42	.9491	63	56	71
3	57	15	46	15	43	74	65	36	72
4	43	16	30	16	44	57	67	15	72
5	30	16	13	17	45	39	68	.9294	73
6	16	17	.9897	18	46	21	69	72	74
7	04	18	82	19	47	03	70	51	74
8	.9891	18	67	20	48	.9384	70	29	75
9	79	19	53	21	49	65	71	07	75
10	67	20	39	22	50	46	72	.9185	76
11	55	20	26	23	51	27	72	63	76
12	44	21	14	24	52	07	73	40	76
13	33	22	01	25	53	.9287	73	18	77
14	22	23	.9789	26	54	66	74	.9095	77
15	12	24	77	27	55	46	74	73	78
16	02	25	65	28	56	24	75	50	78
17	.9792	26	53	30	57	03	75	28	78
18	82	27	41	31	58	.9181	75	05	79
19	72	28	29	33	59	59	76	.8983	79
20	62	29	17	35	60	37	76	60	79
21	52	31	05	37	61	15	76	38	80
22	42	32	.9692	39	62	.9092	77	14	80
23	32	33	79	41	63	70	77	.8891	80
24	22	35	66	43	64	45	78	68	80
25	11	37	52	45	65	22	78	44	81
26	01	38	38	47	66	00	79	20	81
27	.9690	40	24	49	67	.8977	79	.8796	81
28	79	42	10	51	68	53	79	71	81
29	68	43	.9594	53	69	29	80	47	81
30	57	45	79	55	70	05	80	22	81
31	45	46	63	57	71	.8880	80	.8699	82
32	33	48	46	59	72	54	81	75	82
33	21	49	29	60	73	27	81	51	82
34	08	51	11	62	74	01	81	27	82
35	.9595	53	.9493	64	75	.8774	82	03	82
36	81	54	75	65	76	47	82	.8579	82
37	67	56	56	66	77	20	82	55	82
38	53	57	37	68	78	.8693	82	31	83
39	38	59	17	69	79	66	82	06	83
40	22	60	.9397	70	80	38	82	.8482	83

ALCOHOL TABLE — CONTINUED.

Per cent.	Alcohol. Volume per cent.		Alcohol. Weight per cent.		Per cent.	Alcohol. Volume per cent.		Alcohol Weight per cent.	
	Sp. gr.	Correct'n for 1.°C.	Sp. gr.	Correct'n for 1.° C.		Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.
81	.8611	82	.8457	83	91	.8306	84	8200	84
82	.8582	82	32	83	92	.8272	84	.8193	84
83	54	82	07	84	93	36	84	45	84
84	25	82	.8382	84	94	.8199	84	17	84
85	.8495	82	56	84	95	61	84	.8089	84
86	65	83	31	84	96	21	84	60	83
87	35	83	03	84	97	.8079	83	31	83
88	03	83	.8290	84	98	35	83	01	83
89	.8371	83	53	84	99	.7989	83	.7971	82
90	39	83	27	84	100	.39	82	.37	82

Corrections for Temperature.

NOTE.—It will be observed that temperature corrections are given in Table C. for each degree of the centigrade thermometer, and for each 1 per cent. throughout the whole table This is to enable any one using this table to take the specific weight at any temperature, afterwards making such correction as may be required for the deviation from the standard temperature.

Whenever specific weight is taken without reducing the liquid to exactly standard temperature, the correction indicated in the table is to be added to the observed specific weight if the temperature be above 15.° C., and subtracted from it if below 15.° C.

Ex.: Supposing the specific weight of a specimen of hydrochloric acid is taken by the pycnometer at 20.° C., and found to be 1.152. By the table it is seen that the acid contains about 30 per eent. hydrogen chloride; the correction for temperature—five degrees above 15.° C.—will be, by the table, .00065×5=.00325 to be added to the 1.152, giving the specific weight as 1.15525 at 15.° C.

LE C.—SPECIFIC WEIGHTS OF ACIDS AND AMMONIA AT 15° C.

Sp. gr. at 15.° C. (59.° F.); water at 15.°=1.000.

		ect'n .° C.	Nitric Acid. HNO_3		Phosphoric Acid. H_3PO_4.		Acetic Acid. $HC_2H_3O_2$.		Hydrochloric Acid. HCl.		Ammonia. NH_3.		Per cent.
			Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	
	~00	.00014	1.0000	.00014	1.0000	.00014	1.0000	.00014	1.0000	.00014	1.0000	.00014	0
1	1.0066	16	1.0057	16	1.0057	15	1.0015	16	1.0050	15	.9959	15	1
2	132	18	114	18	113	16	30	17	099	16	918	17	2
3	198	21	172	20	170	16	45	18	149	17	878	18	3
4	265	23	229	22	227	17	60	20	198	18	838	20	4
5	333	25	287	24	283	18	75	21	247	19	799	22	5
6	402	27	345	27	341	19	91	22	297	20	761	23	6
7	471	29	404	31	399	20	1.0106	24	346	22	722	25	7
8	541	32	464	35	457	21	21	25	395	24	681	27	8
9	611	34	524	39	517	22	35	27	444	25	647	28	9
10	682	36	584	43	577	22	50	28	494	27	610	30	10
11	753	38	644	46	637	23	65	30	543	29	574	32	11
12	825	40	805	50	698	24	79	31	593	30	538	34	12
13	897	41	766	54	759	25	93	33	643	32	503	35	13
14	970	43	828	57	821	26	1.0208	34	693	34	469	37	14
15	1.1043	45	889	61	882	27	22	36	743	36	436	39	15
16	117	46	951	65	945	27	36	37	793	38	403	41	16
17	191	48	1.1013	68	1.1008	28	50	39	844	39	370	42	17
18	265	49	075	72	072	29	67	40	894	41	338	44	18
19	340	51	138	76	136	30	79	42	945	43	307	45	19
20	415	52	201	80	201	31	93	43	996	45	275	47	20
21	491	54	264	82	266	32	1.0307	44	1.1047	47	244	48	21
22	567	55	328	84	332	33	20	46	099	49	214	50	22
23	644	57	392	86	399	34	33	47	150	51	183	51	23
24	722	58	456	88	467	35	46	48	201	53	153	53	24
25	801	60	521	80	535	36	59	50	253	55	123	54	25

TABLE C —SPECIFIC WEIGHTS OF ACIDS AND AMMONIA AT 15° C.—Continued.

Per cent.	Sulphuric Acid. H_2SO_4.		Nitric Acid. HNO_3.		Phosphoric Acid. H_3PO_4.		Acetic Acid. $HC_2H_3O_2$.		Hydrochloric Acid. HCl.		Ammonia. NH_3.		Per cent.
	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C	Sp. gr-	Correct'n for 1° C.	Sp. gr.	Correct'n for 1.° C.	
26	1.1880	60	1.1586	.00092	.11605	.00036	1.0372	.00051	1.1305	.00057	1.0094	.00056	26
27	959	61	652	93	674	37	84	53	358	59	064	58	27
28	1.2038	62	718	95	745	38	97	54	410	61	034	59	28
29	118	63	784	96	816	39	1.0400	55	463	63	005	61	29
30	198	63	850	97	889	40	14	57	515	65	.8977	63	30
31	279	64	915	99	462	40	27	58	566	66			31
32	361	64	981	.00100	1.2035	41	40	59	616	68			32
33	443	64	1.2047	101	110	42	53	60	667	69			33
34	526	65	113	103	184	43	66	61	716	71			34
35	609	65	179	104	260	43	79	62	765	72			35
36	693	65	244	105	336	44	90	63	813	74			36
37	777	65	310	106	412	45	1.0501	64	861	75			37
38	862	65	376	106	489	46	11	65	908	77			38
39	947	65	443	107	567	46	22	67	954	78			39
40	1.3033	65	509	108	645	47	32	68	1.2000	80			40
41	120	66	576	109	725	47	42	69	445	81			41
42	207	66	643	110	805	48	52	70	885	83			42
43	295	66	711	110	885	49	61	71					43
44	384	67	778	111	967	49	71	72					44
46	474	67	845	112	1.3050	50	80	73					45
46	565	67	913	113	133	51	89	74					46
47	658	68	980	114	219	52	98	74					47
48	753	68	1.3045	115	304	52	1.0607	75					48
49	849	69	109	116	391	53	16	76					49
50	946	69	172	117	47	54	24	77					50

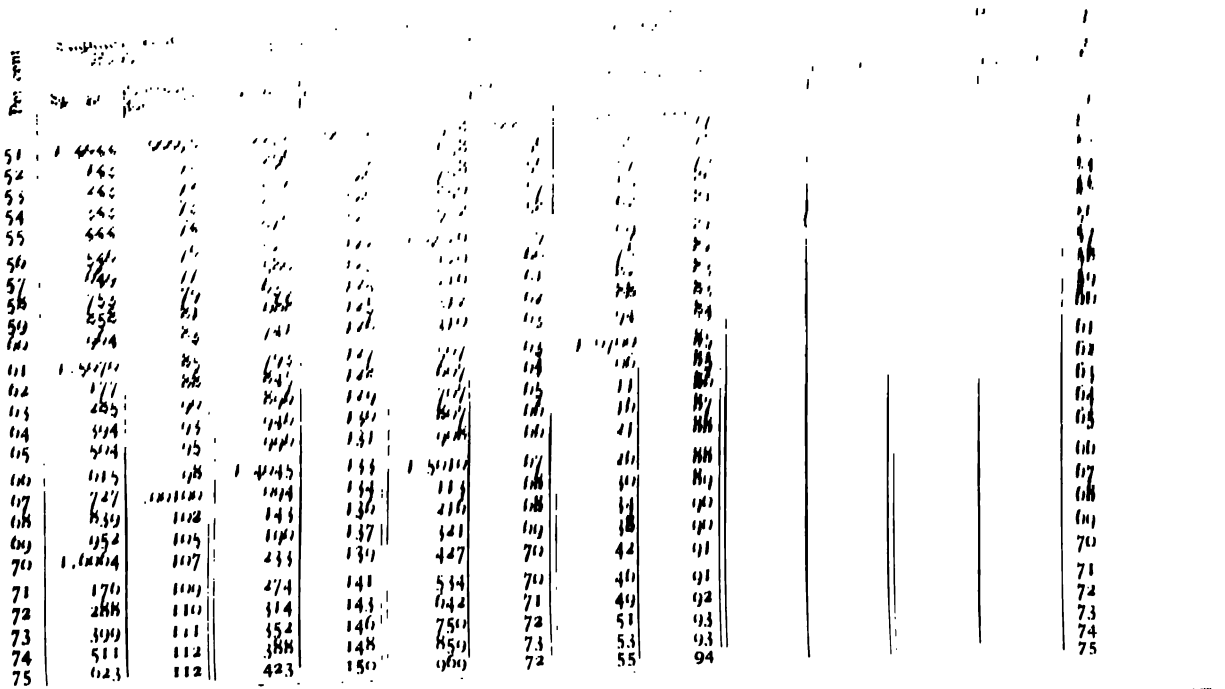


TABLE C.—SPECIFIC WEIGHTS OF ACIDS AND AMMONIA AT 15° C.—Continued.

Per cent.	Sulphuric Acid. H_2SO_4.		Nitric Acid. HNO_3		Phosphoric Acid. H_3PO_4.		Acetic Acid. $HC_2H_3O_2$.		Hydrochloric Acid. HCl.		Ammonia. NH_3.		Per cent.
	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	Sp. gr.	Correct'n for 1.° C.	
76	1.6734	.00111	1.4459	.00152	1.6080	.00072	1.0756	.00094					76
77	846	110	494	154	190	71	57	95					77
78	957	109	529	156	802	71	57	96					78
79	1.7068	107	563	158	415	70	57	96					79
80	179	106	597	160	528	70	57	97					80
81	290	105	631	162	642	70	56	97					81
82	400	104	665	164	756	70	55	98					82
83	509	103	699	165	871	70	53	98					83
84	615	102	733	167	986	69	51	99					84
85	718	101	767	169	1.7102	69	48	.00100					85
86	818	100	801	171			45	100					86
87	913	.00099	835	173			40	101					87
88	1.8003	98	869	174			35	101					88
89	083	97	903	176			29	102					89
90	153	96	938	178			22	102					90
91	213	95	973	179			14	103					91
92	263	95	1.5008	180			05	103					92
93	303	95	044	182			1.0695	104					93
94	335	95	080	183			83	104					94
95	362	95	116	184			69	105					95
96	384	95	152	186			53	105					96
97	395	95	188	188			34	106					97
98	405	95	224	189			13	106					98
99	410	95	262	191			1.0589	107					99
100	1.8390	95	1.5300	193				108					100

SPECIFIC VOLUME.

388. By **Specific Volume** is meant here the ratio of the volume of any liquid as compared with the volume of an equal weight of water.*

389. Specific volume in this sense is, in other words, the opposite of specific weight or specific gravity.

390. The specific volumes of substances are inversely as their specific gravities.

391. **How found.**—The specific volume of a body is found by dividing 1 by the specific weight of that body.

Ex.: As the specific weight of glycerin is 1.25, the specific volume of glycerin is

$$\frac{1}{1.250} = 0.800.$$

The product obtained by multiplying the specific weight by the specific volume of the same substance is, therefore, always 1.

The specific volume of a liquid is also found by dividing the weight of a given volume of water by the weight of an equal volume of that liquid.

392. The weight in Grams of any liquid multiplied by its specific volume or divided by its specific weight, at once gives its measure in Cubic-centimeters.

Hence, in the official working formulæ for solutions, the final product in Grams can, by the aid of specific volume, be at once reduced to actual volume in Cubic-centimeters.

The weight in avoirdupois ounces of any liquid can be reduced to the corresponding volume in Imperial fluidounces in the same manner, *i.e.*, by multiplying the number of avoirdupois ounces by the specific volume of the liquid, or by dividing it by its specific weight.

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* See paper read by the author before the American Pharmaceutical Association at the Washington meeting, 1883, in which paper the use of "specific volume" was proposed, and its definition and utility stated.

393. "As 100 avoirdupois ounces of water measures 96 U. S. fluidounces, the volume of 100 avoirdupois ounces of any other liquid may be obtained in U. S. fluidounces by simply multiplying its specific volume by 96. Thus 100 avoirdupois ounces of solution of tersulphate of iron measures

$$0.758 \times 96 = 72.77 \text{ U. S. fluidounces."}$$

(Companion to U. S. P.)

394. Another method of finding the volume of a certain weight of any liquid is to multiply the number of measure units (of one kind) representing an equal weight of water by the specific volume of the liquid.

Ex.: To find the volume of 50 lbs. of glycerin. As the specific volume of glycerin is 0.800, and as the volume of 50 lbs. water is 48 wine pints; therefore, 50 lbs. of glycerin measures $48 \times 0.800 = 38.4$ wine pints.

395. The following table of specific volumes has been prepared by Dr. A. B. Lyons, of Detroit, and is inserted here by his courtesy.

It is in my opinion the best table yet suggested for the comparison of weight and volume.

Although the specific weights and specific volumes are referred to water at the standard temperature of 15.° C. (59.° F.), these relations between the specific weights and the specific volumes of course apply equally well if water at any other temperature be chosen as unit.

The actual weights and measures, as given in this table, are true only at 16.°67 C. (62.° F.).

SPECIFIC VOLUMES AND ACTUAL WEIGHTS AND MEASURES CORRESPONDING WITH GIVEN SPECIFIC GRAVITIES.

Specific gravity at 59.0 F.; water at same temp.= 1.000.	Specific Volume at 59.0 F.	Difference in specific volume corresponding with .001 in sp. gr.	Volume of 100 oz. av. in U. S. fluidounces.	Volume of 1,000 grs. in U. S. fluidounces.	Volume of 100 grs. in minims.	Weight of one wine pint in grains.	Weight of one U. S. fl. oz. in grains.	Weight of one U. S. fl. oz. in av. ounces.
.700	1.4286	.00201	137.16	3.135	150.49	5103.4	318.96	.7291
10	085	196	135.23	3.091	148.37	5176.3	323.52	.7395
20	.3889	90	133.35	3.048	146.31	5249.3	328.08	.7499
30	699	85	131.53	3.006	144.30	5322.2	332.63	.7603
40	514	80	129.75	2.966	142.35	5395.1	337.20	.7707
50	333	75	128.02	2.926	140.45	5468.0	331.75	.7811
60	158	71	126.33	2.888	138.61	5540.9	346.30	.7916
70	.2987	67	124.70	2.850	136.81	5613.8	350.86	.8020
80	821	62	123.09	2.814	135.05	5686.7	355.42	.8124
90	658	58	121.54	2.778	133.34	5759.6	359.97	.8228
.800	500	55	120.02	2.743	131.68	5832.5	364.53	.8332
05	422	53	119.27	2.726	130.86	5868.9	366.81	.8384
10	346	52	118.54	2.709	130.05	5905.4	369.09	.8436
15	270	50	117.81	2.693	129.25	5941.9	371.37	.8488
20	195	48	117.09	2.676	128.46	5978.3	373.64	.8540
25	121	46	116.38	2.660	127.69	6014.8	375.92	.8593
30	048	44	115.58	2.644	126.92	6051.2	378.20	.8645
35	.1976	43	114.99	2.628	126.16	6087.7	380.48	.8697
40	905	41	114.30	2.613	125.41	6124.1	382.76	.8749
45	834	39	113.64	2.597	124.66	6160.6	385.04	.8801
50	765	38	112.96	2.582	123.93	6197.0	387.31	.8853
55	696	36	112.30	2.567	123.20	6233.5	389.59	.8905
60	628	34	111.64	2.552	122.49	6269.9	391.87	.8957
65	561	33	111.00	2.537	121.78	6306.4	394.15	.9009
70	494	31	110.34	2.523	121.08	6342.8	396.43	.9061
75	429	30	109.73	2.508	120.39	6379.3	398 71	.9113
80	364	28	109.11	2.494	119.70	6415.8	400.98	.9165
85	300	27	108.49	2.480	119.03	6452.2	403.26	.9217
90	236	26	107.88	2.466	118.36	6488.7	405.54	.9270
95	173	24	107.28	2.452	117.70	6525.1	407.82	.9322
.900	111	23	106.68	2.438	117.05	6561.6	410.10	.9374
05	050	21	106.09	2.425	116.40	6598.0	412.38	.9426
10	.0989	20	105.51	2.412	115.76	6634.5	414.65	.9478
15	929	19	104.93	2.398	115.13	6670.9	416.93	.9530
20	870	18	104.36	2.385	114.51	6707.4	419.21	.9582
25	811	16	103.80	2.373	113.89	6743.8	421.49	.9634

Specific gravity at 59.° F. water at same temp.= 1,000.	Specific volume at 59.° F.	Difference in specific volume corresponding with .001 in sp. gr.	Volume of 100 oz., av. in U. S. fluid-ounces.	Volume of 1,000 grs. in U. S. fluidounces.	Volume of 100 grs. in minims.	Weight of one wine pint in grains.	Weight of one U. S. fluidounce in grains.	Weight of one U. S. fl. oz. in av. ounces.
.930	1.0753	.00115	103.24	2.360	113.27	6780.3	423.77	.9686
35	695	14	102.69	2.347	112.66	6816.7	426.05	.9738
40	638	13	102.14	2.335	112.06	6853.2	428.32	.9790
45	582	11	101.60	2.322	111.47	6889.6	430.60	.9842
50	526	10	101.07	2.310	110.89	6926 1	432.88	.9894
55	471	09	100.54	2.298	110.30	6962.5	435.16	.9946
60	417	08	100.15	2.286	109.73	6999.0	437.44	.9999
65	363	07	99.50	2.274	109.16	7035.5	439.72	1.0051
70	309	06	98.98	2.262	108.60	7071.9	441.99	1.0103
75	256	05	98.48	2.251	108.04	7108.4	444.27	1.0155
80	204	04	97.97	2.239	107.49	7144.8	446.55	1.0207
85	152	03	97.48	2.228	106 95	7181.3	448.83	1.0259
90	101	02	96.98	2.217	106.41	7217.7	451.11	1.0311
95	050	01	96.50	2.206	105.87	7254.2	453.39	1.0363
1.000	1.0000	.00099	96.01	2.195	105.34	7290.6	455.66	1.0415
1.01	.9901	97	95.06	2.173	104.30	7363.5	460.22	1.0519
2	804	95	94.13	2.152	103.28	7436.4	464.78	1.0623
3	709	93	93.22	2.131	102.27	7509.3	469.33	1.0728
4	615	91	92.32	2.110	101.29	7582.3	473.89	1.0832
5	524	90	91.45	2.090	100.33	7655.2	478.45	1.0936
6	434	88	90.58	2.070	99.38	7728.1	483.00	1.1040
7	346	87	89.73	2.051	98.45	7801.0	487.56	1.1144
8	259	85	88.90	2.032	97.54	7873.9	492.12	1.1248
9	174	83	88.09	2.013	96.64	7946.8	496.67	1.1353
1.10	091	82	87.29	1.995	95.76	8019.7	501.23	1.1457
.11	009	80	86.50	1.977	94.90	8092.6	505.79	1.1561
.12	.8929	79	85.73	1.960	94.00	8165.5	510.34	1.1665
.13	850	78	84.97	1.942	93.22	8238.4	514.90	1.1769
.14	772	76	84.22	1.925	92.40	8311.3	519.46	1.1873
.15	696	75	83.49	1.908	91.60	8384.2	524.01	1.1977
.16	621	74	82.77	1.892	90.81	8457.1	528.57	1.2082
.17	547	72	82.06	1.876	90.03	8530.0	533.13	1.2186
.18	475	71	81.37	1.860	89.27	8602.9	537.68	1.2290
.19	403	70	80.69	1.844	88.52	8675.8	542.24	1.2394
.20	333	69	80.01	1.829	87.78	8748.8	546.80	1.2498
.21	265	68	79.35	1.814	87.06	8821.7	551.35	1.2603
.22	197	67	78.70	1.799	86.34	8894.6	555.91	1.2707
.23	130	66	78.06	1.784	85.64	8967.5	560.47	1.2811
.24	065	64	77.43	1.770	84.95	9040.4	565.02	1.2915
.25	000	63	76.81	1.756	84.27	9113.3	569.58	1.3019

Specific gravity at 59.° F. water at same temp=1,000.	Specific volume at 59.° F.	Difference in specific volume corresponding with .001 in sp. gr.	Volume of 100 oz. in U. S. fl. oz.	Volume of 1,000 grs. in U. S. fl. oz.	Volume of 100 grs. in minims.	Weight of one wine pint in grains.	Weight of one U. S. fl. oz. in grains.	Weight of one U. S. fl. oz. in av. ounces.
1.26	.7937	.00063	76.20	1.742	83.60	9186.2	574.14	1.3123
.27	874	62	75.60	1.728	82.95	9259.1	578.69	1.3227
.28	813	61	75.01	1.715	82.30	9332.0	583.25	1.3331
.29	752	60	74.43	1.701	81.66	9404.9	587.71	1.3436
.30	692	58	73.86	1.688	81.03	9477.8	592.30	1.3540
.31	634	58	73.29	1.675	80.41	9550.7	596.92	1.3644
.32	576	57	72.74	1.663	89.81	9623.6	601.48	1.3748
.33	519	56	72.20	1.650	79.21	9696.5	606.03	1.3852
.34	463	56	61.65	1.638	78.61	9769.4	610.59	1.3956
.35	407	54	71.12	1.626	78.03	9842.3	615.15	1.4060
.36	353	54	70.60	1.614	77.46	9915.3	619.70	1.4165
.37	299	53	70.08	1.602	76.89	9988.2	624.26	1.4269
.38	246	52	69.58	1.590	76.33	10061.1	628.82	1.4373
.39	194	51	69.08	1.579	75.78	10134.0	633.37	1.4477
.40	143	51	68.58	1.568	75.24	10206.9	637.93	1.4581
.41	092	50	68.10	1.557	74.71	10279.8	642.49	1.4685
.42	042	49	67.62	1.546	74.18	10352.7	647.04	1 4790
.43	.6993	49	67.14	1.535	73.67	10425.6	651.60	1.4894
.44	944	48	66.68	1.524	73.15	10498.5	656.16	1.4998
.45	896	47	66.22	1.514	72.65	10571.4	660.71	1.5102
.46	849	46	65.76	1.503	72.15	10644.3	665.27	1.5206
.47	803	46	65.32	1.493	71.66	10717.2	669.83	1.5310
.48	757	45	64.87	1.483	71.18	10790.1	674.38	1.5414
.49	712	45	64.44	1.473	70.70	10863.0	678.94	1.5519
.50	667	44	64.01	1.463	70.23	10935.9	683.50	1.5623
.51	623	44	63.59	1.453	69.76	11008.8	687.95	1.5727
.52	579	43	63.17	1.444	69.30	11081.8	692.51	1.5831
.53	536	42	62.75	1.434	68.85	11154.7	697.07	1.5935
.54	494	42	62.35	1.425	68.40	11227.6	701.62	1.6039
.55	452	42	61.95	1.416	67.96	11300.5	706.18	1.6144
.56	410	41	61.55	1.407	67.53	11373.4	710.73	1.6248
.57	369	40	61.13	1.398	67.10	11446.3	715.39	1.6352
.58	329	40	60.77	1.389	66.67	11519.2	719.95	1.6456
.59	289	39	60.39	1.380	66.25	11592.1	724.51	1.6560
.60	250	39	60.01	1.372	65.84	11665.0	729.06	1.6664
.61	211	38	59.64	1.363	65.43	11737.9	733.62	1.6768
.62	173	38	59.27	1.355	65.02	11810.8	738.18	1.6873
.63	135	37	58.90	1.346	64.63	11883.7	742.73	1.6977
.64	098	37	58.55	1.338	64.23	11956.6	747.29	1.7081
.65	061	37	58.19	1.330	63.84	12029.5	751.85	1.7185

Specific gravity at 59.0 F. water at same temp=1,000.	Specific volume at 59.0 F.	Difference in specific volume corresponding with .001 in sp. gr.	Volume of 100 oz, av. in U. S. fl. oz.	Volume of 1,000 grs. in U. S. fl. oz	Volume of 100 grs. in minims	Weight of one wine pint in grains.	Weight of one U. S. fl. oz. in grains.	Weight of one U. S. fl. oz. in av. ounces.
1.66	.6024	36	57.84	1.322	63.46	12102.4	756.40	1.7289
.67	.5988	36	57.49	1.314	63.08	12176.3	760.96	1.7393
.68	952	35	57.15	1.306	62.70	12248.3	765.52	1.7498
.69	917	35	56.81	1.299	62.33	12321.2	770.07	1.7602
.70	882	34	56.48	1.291	61.97	12394.1	774.63	1.7706
.71	848	34	56.15	1.284	61.60	12467.0	779.19	1.7810
.72	814	34	55.79	1.276	61.24	12539.9	783.74	1.7914
.73	780	33	55.50	1.269	60.89	12612.8	788.30	1.8018
.74	747	33	55.18	1.261	60.54	12685.7	792.80	1.8122
.75	714	32	54.87	1.254	60.19	12758.6	797.41	1.8227
.76	680	32	54.55	1.247	59.85	12831.5	801.97	1.8331
.77	650	32	54.25	1.240	59.51	12904.4	806.53	1.8435
.78	618	32	53.94	1.233	59.18	12977.3	810 08	1.8539
.79	587	31	53.64	1.226	58.85	13050.2	815.64	1.8643
.80	556	31	53.34	1.219	58.52	13123.1	820.20	1.8747
.81	525	30	53.05	1.213	58.20	13196.0	824.75	1.8851
.82	495	30	52.76	1.206	57.88	13268.9	829.31	1.8956
.83	465	30	52.47	1.200	57.56	13341.8	833.87	1.9060
.84	435	30	52.18	1.193	57.25	13414.8	838.42	1.9164
.85	405	30	51.90	1.186	56.94	13487.7	842.98	1.9268

TABLE OF SPECIFIC WEIGHTS AND SPECIFIC VOLUMES OF PHARMACAL LIQUIDS.

(Temperature 15.° C. (59.° F.), except for Alcohol, Diluted Alcohol and Distilled Water.)

LIQUID.	WEIGHT.			VOLUME.		
	Specific weight.	Weight of 1,000 C.c. in Grams.	Weight of 100 U. S. fluidounces in avoirdupois ounces.	Specific volume.	Volume of 1,000 Grams in Cubic Centimeters.	Volume of 100 Avoirdupois oz. in U. S. fluidounces.
Acidum Aceticum, U. S.	1.048	1,048	109.1	0.954	954	91.6
Acidum Aceticum Dilutum, U. S.	1.0083	1,008.3	105.1	0.992	992	95.2
Acidum Aceticum Glaciale U. S.	1.057	1,057	110.2	0.945	945	90.8
Acidum Hydrobromicum, 34 per cent	1.303	1,303	135.7	0.767	767	73.6
Acidum Hydrobromicum Dilutum, U. S.	1.077	1,077	112.2	0.928	928	89.1
Acidum Hydrochloricum, U. S.	1.160	1,160	120.8	0.862	862	82.8
Acidum Hydrochloricum Dilutum, U. S.	1.049	1,049	109.3	0.953	953	91.5
Acidum Lacticum, U. S.	1.212	1,212	126.3	0.825	825	79.2
Acidum Nitricum, U. S.	1.420	1,420	148.0	0.704	704	67.6
Acidum Nitricum Dilutum, U. S.	1.059	1,059	110.4	0.944	944	90.6
Acidum Oleicum, U. S.	0.910	910	94.8	1.099	1,099	105.5
Acidum Phosphoricum, U. S.	1.347	1,347	140.4	0.742	742	71.2
Acidum Phosphoricum Di-[illegible]tum, U. S.	1.057	1,057	110.2	0.946	946	90.8
[illegible]m Sulphuricum, U.S.	1.840	1,840	191.8	0.543	543	52.1
[illegible] Sulphuricum Aro-[illegible]m, U. S.	0.955	955	99.5	1.047	1,047	100.5
[illegible]lphuricum Dilu-[illegible]	1.067	1,067	111.1	0.937	937	90.0
[illegible]rosum, U.S.	1.023	1,023	106 5	0.978	978	93.9
[illegible]	0.750	750	78.1	1.333	1,333	128.0
[illegible]. S.	0.892	892	92.9	1.121	1,121	107.6
[illegible] S.	0.725	725	75.5	1.379	1,379	132.4
[illegible] 5.° 6 C.	0.820	820	85.4	1.219	1,219	117.1
[illegible] 5.° C.	0.812	812	84.6	1.231	1,231	118.2
[illegible] S., at [illegible]	0.928	928	96.7	1.077	1,077	103.4

LIQUID.	WEIGHT.			VOLUME.		
	Specific weight.	Weight of 1,000 C.c. in Grams.	Weight of 100 U. S. fluidounces in avoirdupois ounces.	Specific volume.	Volume of 1,000 Grams in Cubic Centimeters.	Volume of 100 Avoirdupois oz. in U. S. fluidounces.
Alcohol Dilutum, U. S., at 25.° C.	0.920	920	95.8	1.087	1,087	104.4
Amyl Nitris, U. S.	0.873	873	90.9	1.146	1,146	110.0
Aqua Distillata, at +4 °C.	1.000	1,000	104.2	1.000	1,000	96.0
Aqua Ammoniæ, U. S.	0.959	959	99.9	1.043	1,043	100.1
Aqua Ammmoniæ Fortior, U. S.	0.900	900	93.8	1.111	1,111	106.6
Aquæ Aromat., at +4.° C.	1.000	1,000	104.2	1.000	1,000	96.0
Balsamum Peruvianum	1.140	1,140	118.8	0.877	877	84.2
Benzinum, U. S.	0.670	670	69.8	1.493	1,493	143.3
Bromum	2.990	2,990	311.5	.3344	334	32.1
Carbonei Bisulphidum	1.272	1,272	132.5	0.786	786	75.5
Chloroformum Purif., U.S.	1.487	1,487	155.1	0.672	672	64.5
Chlorof. Venale, U. S.	1.470	1,470	153.1	0.680	680	65.3
Copaiba	0.960	960	100.0	1.042	1,042	100.0
Creasotum	1.060	1,060	110.5	0.9434	943	90.5
Glycerinum, U. S.	1.250	1,250	130.2	.800	800	76.8
Liquor Acidi Arseniosi, U. S	1.000	1,000	104.2	1.000	1,000	96.0
Liquor Ammonii Acetatis, U. S	1.022	1,022	106.5	0.9784	978	93.9
Liquor Arsenii et Hydrargyri Iodidi, U, S.	1.000	1,000	104.2	1.000	1,000	96.0
Liquor Calcis	1.0015	1,001.5	104.3	0.9985	999	95.9
Liquor Ferri Acetatis, U.S.	1.160	1,160	120.8	0.862	862	82.8
Liquor Ferri Chlor., U. S.	1.405	1,405	146.4	0.712	712	68.3
Liquor Ferri Citratis, U. S	1.260	1,260	131.4	0.793	793	76.1
Liquor Ferri Nitratis, U. S.	1.050	1,050	109.4	0.952	952	91.4
Liquor Ferri Subsulphatis, U. S.	1.555	1,555	157.5	0.643	643	63.5
Liquor Ferri Tersulphatis, U. S.	1.320	1,320	137.4	0.758	758	72.8
Liquor Hydrargyri Nitratis, U. S.	2.100	2,100	218.8	0.476	476	45.7
Liquor Plumbi Subacetatis, U. S.	1.228	1,228	128.0	0.814	814	78.1
Liquor Potassæ, U. S.	1.036	1,036	108.0	0.965	965	92.6
Liquor Potassæ, Ph. German	1.144	1,144	119.2	0.874	874	83.9
Liquor Potassii Arsenitis	1.000	1,000	104.1	1.000	1,000	96.0
Liquor Potassii Citratis	1.059	1,059	110.4	0.944	944	90.6
Liquor Sodæ, U. S.	1.059	1,059	110.4	0.944	944	90.6

[illegible]	WEIGHT.			VOLUME.		
	Specific weight.	[illegible]	[illegible]	Specific volume.	[illegible]	[illegible]
Liquor Sodae [illegible] Germ.	[illegible]	[illegible]	[illegible]	1.[illegible]	[illegible]	[illegible]
Liquor Sodae Chlor. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Liquor Sodii Arsenatis [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Liquor Zinci Chloridi [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mel [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mel [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oleum [illegible]	[illegible]	[illegible]	[illegible]	1.111	1,111	[illegible]
Oleum [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	105.5
Oleum [illegible]	[illegible]	[illegible]	95.5	1.091	1,091	104.7
Oleum [illegible]	[illegible]	[illegible]	102.1	1.020	1,020	97.9
Oleum [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	111.0
Oleum [illegible]	[illegible]	[illegible]	91.1	1.143	1,143	109.7
Oleum Caryophylli	1.0[illegible]	1,0[illegible]	109.4	0.952	952	91.4
Oleum Cassiae	1.0[illegible]	1,0[illegible]	113.5	0.9434	943	90.5
Oleum Chenopodii	0.890	890	92.8	1.123	1,123	107.8
Oleum Cubebae	0.920	920	95.8	1.087	1,087	104.4
Oleum Erigerontis	0.900	900	93.8	1.111	1,111	106.6
Oleum Gaultheriae	1.173	1,173	122.3	0.852	852	81.8
Oleum Gossypii Seminis	0.925	925	96.4	1.081	1,081	103.8
Oleum Lavandulae Florum	0.890	890	92.8	1.123	1,123	107.8
Oleum Limonis	0.850	850	88.5	1.176	1,176	112.9
Oleum Lini	0.936	936	97.6	1.068	1,068	102.5
Oleum Menthae Piperitae	0.900	900	93.8	1.111	1,111	106.6
Oleum Morrhuae	0.920	920	95.8	1.087	1,087	104.4
Oleum Olivae	0.917	917	95.5	1.091	1,091	104.7
Oleum Ricini	0.960	960	100.0	1.042	1,042	100.0
Oleum Sassafras	1.091	1,091	113.6	0.917	917	88.0
Oleum Sesami	0.917	917	95.5	1.091	1,091	104.7
Oleum Terebinthinae	0.860	860	89.6	1.163	1,163	111.3
Spir. Ether. Nitrosi, U. S.	0.824	824	85.8	1.214	1,214	116.5
Spiritus Ammoniae, U. S.	0.810	810	84.4	1.235	1,235	118.5
Spir. Ammon. Aromat. U. S.	0.885	885	92.2	1.130	1,130	108.5
Spiritus Frumenti	0.920	920	95.9	1.087	1,087	104.3
Spiritus Vini Gallici	0.930	930	96.9	1.075	1,075	103.2
Syrupus (Simplex), U. S.	1.310	1,310	136.6	0.764	764	73.2
Syr. Acidi Hydriod., U. S.	1.300	1,300	136.1	0.768	768	73.4
Tinct. Ferri Acet., U. S.	0.950	950	98.9	1.053	1,053	101.1
Tinct. Ferri Chlor., U. S.	0.980	980	102.2	1.020	1,020	97.9
Vinum Album, U. S.	1.000	1,000	104.2	1.000	1,000	96.0
Vinum Rubrum, U. S.	1.000	1,000	104.2	1.000	1,000	96.0

NOTE.—It is to be remembered that some of these specific weights refer to water at 15.° C., and others to water at 4.° C., and also that 1,000 C.c. water at 15.° C. weighs only 998 Grams. These causes of error, being comparatively unimportant, are ignored.

RELATIONS OF WEIGHT TO VOLUME AND OF VOLUME TO WEIGHT.

396. Comparisons between weight and volume are perhaps of more frequent occurrence in pharmacy than in any other study or art. The construction of working formulæ in parts by weight in all recent Pharmacopœias except the new American and British Pharmacopœias, and the partial adoption of that method in the Pharmacopœia of the United States, render comparisons and computations of this kind frequently necessary. Rules for computing the volume of given quantities by weight, and the weight of given quantities by volume have been laid down in paragraphs 386 and 392.

397. We have already seen that the natural connecting link between weight and volume—the medium through which weight and volume and the measures of both are compared—is water. The tables of equivalents which are given in this chapter, therefore, apply without correction only to water and other liquids of the same specific weight. But the equivalents given can be applied to all liquids of which the specific weight is known, using the rules in paragraphs 386 and 392.

398. **The Liter and Kilogram.** The *theoretical kilogram* is the weight of one liter of water at its maximum density, weighed *in vacuo*. At the temperature of $+4.^{\circ}$ C. ($39.^{\circ}2$ F.), therefore, one liter and one true kilogram of pure water are equal quantities.

The *actual prototype platinum kilogram* of the Archives is, however, deficient in weight to the extent of about 9 grains.

399. The weight *in vacuo* of one cubic inch of water at $62.^{\circ}$ F., as obtained by Kater and revised by Barnard,* is 252.75965 grains.

* See "Metric System," by F. A. P. Barnard, Boston, 1879; p. 174.

This value, multiplied by 1.001078, the co-efficient of volume of water at 62.° F., deduced from Kopp's tables $-4.°$ C. $= 1.000$ gives 253.03211 grains as the weight, *in vacuo*, of one cubic inch of water at maximum density ($+4.°$C.)

400. Assuming the meter to be equal to 39.370432 inches (Clarke), the liter is equal to 61.02538677 cubic inches; and if the kilogram is equal to 15.432348[7]4 grains (Miller), then the weight *in vacuo* of one cubic inch of water at maximum density deduced from these determinations would be 252.884097 grains.

401. The weight *in vacuo* of one liter of water at maximum density, deduced from the weight of one cubic inch $=253.03211$, should be 15,441.38238 grains, which exceeds the weight of the platinum prototype kilogram of the Archives as determined by Miller (15,432.34874) by 9.034 grains.

402. The theoretical kilogram (399) is the *true kilogram* of the Metric System; and the platinum prototype kilogram of the Archives, if correct, should agree with it—that is, it should be the exact weight *in vacuo* of one liter of water at maximum density. We have seen, however, that the platinum weight made to represent the true kilogram is 9 grains too light.

Practically, the kilogram of the Archives, although known to be too light, is nevertheless the actual standard by which the weights of the Metric System are standarded.

403. One liter of water at maximum density, while weighing *in vacuo* exactly one theoretical kilogram, weighs 1.00058537 kilograms of the Archives.

404. Having accepted the value, 252.75965 grains, as the true weight *in vacuo* of one cubic inch of water at 62.° F., we find the corresponding weight *in air* at the same temperature by subtracting 0.27122 grains,* representing the weight of the air displaced by the water less the weight of the air displaced by the brass weights. The result thus obtained is 252.48843 grains.

* *See Barnard's* "The Metric System," Boston, 1879, p. 176.

WEIGHT OF ONE CUBIC INCH OF WATER.

The weight in air is assumed to be under ordinary conditions.

(One Cubic Inch water at 62.° F., *in vacuo*=252.75965 grains.)

Temperature.	Grams.		Grains.	
	In vacuo.	In air at 62 °F	In vacuo.	In air at 62.°F.
0.°C. (32.° F.).....	16.39420	16.37664	253.001	252.730
4.° C. (39.°2 F.).....	16.39621	16.37865	253.032	252.761
15.° C. (59.° F.).....	16.38279	16.36522	252.825	252.554
15.°56. C. (60.°F.).....	16.38143	16.36386	252.804	252.533
16.°67 C. (62.° F.).....	16.37856	16.36099	252.75965	252.48843
18.°33 C. (65.° F.).....	16.37379	16.35622	252.686	252.415
20.° C. (68.° F.).....	16.38654	16.35097	252.605	252.334
22.°C. (71.°6 F.).....	16.36154	16.34397	252.497	252.226
25.° C. (77.° F.),.....	16.34981	16 33224	252.316	352.045

DENSITY AND EXPANSION OF WATER.

(From Kopp's Tables, with interpolations..)

Temperature.		Water at 4.° C. (39.°2F.)= 1.		Water at 0.°C. (32.°F.)= 1.	
Centigrade 1.	Fahrenheit 2.	Volume. (In vacuo.) 3.	Weight. (in vacuo) 4.	Volume. (in vacuo). 5.	Weight. (in vacuo) 6.
0	32	1.00012	0.999877	1.00000	1.000000
1	33.8	07	390	0.99995	53
2	35.6	03	969	91	92
3	37.4	01	992	89	115
4	39.2	1.00000	1.000000	88	123
5	41.	01	.999994	88	117
6	42.8	03	973	90	097
7	44 6	06	939	94	62
8	46.4	11	890	99	14
9	48.2	17	829	1.00005	0.999952
10	50.	25	753	12	876
11	51.8	34	664	21	785
12	53.6	44	562	31	686
13	55.4	55	449	43	572
14	57.2	68	322	56	445
14.33	57.8	72	277		
14.67	58.4	77	231		
15.	59.	82	183	1.00070	0.999306
15.33	59.6	87	134		
15.56	60.	90	101		
15.67	60.2	92	084		
16.	60.8	97	032	1.00085	0.999155
16.33	61.4	101	8978		

Temperature.		Water at 4.0 C. (39.2 F.)=1.		Water at 0.0 C. (32.0F.)= 1.	
Centigrade 1.	Fahrenheit 2.	Volume. (In vacuo) 3.	Weight (in vacuo) 4.	Volume (In vacuo) 5.	Weight (in vacuo) 6.
16.67	62.	1.001078	0.9989232		
17.	62.6	113	869	1.00101	0.998992
17.33	63.2	119	812		
17.68	93.8	125	754		
18.	64.4	131	695	1.00118	0.998817
18.33	65	137	634		
18.67	65 6	143	572		
19.	66.2	149	509	1.00137	0 998631
19 33	66.8	156	444		
19.67	67.4	1625	379		
20.	68.	169	312	1.00157	0.998435
21.	69.8	190	104	178	228
22	71.6	212	7886	200	010
23.	73.4	235	657	223	7780
24.	75.2	259	419	247	541
25.	77.	284	170	271	293
26.	78.8	310	6912	295	035
27.	80.6	337	644	319	6767
28	82.4	365	367	347	489
29.	84.2	393	082	376	202
30.	86.	423	5786	406	908
35.	95.			570	
40.	104.			753	
45.	113.			954	
50.	122.			1177	
55.	131.			1410	
60.	140.			1659	
65.	149.			1930	
70.	158.			2225	
75.	167.			2541	
80.	176.			2858	
85.	185.			3189	
90.	194.			3540	
95.	203.			3909	
100.	212.			4299	

405. At the temperatures named the numbers in column 3 of the above table give the number of liters equivalent to one theoretical kilogram, and the numbers in column 4 give the number of theoretical kilograms equal to one liter. Thus 1 (theoretical) kilogram of water at 23.°C. measures 1.00235 liters; and 1 liter of water at 20.° C. weighs 0.998312 (theoretical) kilogram.

406. The following tables have been constructed upon the basis of the data referred to in the preceding paragraphs.

WEIGHT OF ONE LITER OF WATER.

The weight in air is assumed to be under ordinary conditions of pressure and humidity, and with brass weights; air at 62.° F. (16.°67 C.)

(One cubic inch water at 62,° F. *in vacuo*=252.75965 grains.)

Temperatures.	Theoretical Kilograms.		Kilograms of the Archives.		Grains.	
	In vacuo.	In air at 62.° F.	In vacuo.	In air at 62.° F.	In vacuo.	In air at 62.° F.
0.°C ...	0.999877	0.998805	1.000462	0.999389	15,439.483	15,422.932
4.°C....	1.000000	928	585	512	41.382	24.831
15.°C....	0.999183	111	0.999768	8695	28.766	12.215
15.°56C..	101	029	686	613	27.500	10.949
16.°67 C..	8923	7851	508	435	24.755	08.204
18.°33 C..	634	562	218	145	20.289	03.738
20.°C....	312	240	8896	7823	15.317	398.766
22.°C....	7886	6814	470	397	08.739	92.188
25.°C....	170	098	7754	6681	397.683	81.132

WEIGHT OF ONE WINE GALLON OF WATER.

The weight in air is assumed to be under ordinary conditions of pressure and humidity and with brass weights; air at 62.° F. (16.°67 C.)

(One cubic inch water at 62.° F. *in vacuo*, = 252.75965 grains.)

TEMPERATURES.	GRAMS.		GRAINS.	
	In vacuo.	In air at 62.° F.	In vacuo.	In air at 62.° F.
0.°C.....	3,787.060	3,783.000	58,443.229	58,380.577
4.°C.	7.526	3.466	50.417	87.855
15.°C.....	4.431	0.371	02.663	40.011
15.°56 C.....	4.121	0.061	397.870	35.218
16.°67 C.....	3.447	79.387	87.479	24.827
18.°33 C.....	2.352	8.292	70.575	07.923
20.°C.....	1.132	7.072	51.753	289.101
22.°C.....	79.519	5.459	26.853	64.201
25.°C.....	6.807	2.747	285.003	22.351

WEIGHT OF ONE IMPERIAL GALLON OF WATER.

The weight in air is assumed to be under ordinary conditions of pressure and humidity.

(One cubic inch water at 62.° F. weighed in air — 252.48843 grains.)

TEMPERATURES.	GRAMS.		GRAINS.	
	In vacuo.	In air at 62.° F.	In vacuo.	In air at 62.° F.
0.° C.	4,545.135	4,540.263	70,142.098	70,066.905
4.° C.	5.692	820	50.693	75.500
15.° C.	1.972	37.199	093.304	18.111
15.56 C.	1.595	6.772	87.482	12.289
16.07 C.	0.799	5.926	75.193	70,000.000
18.33 C.	39.476	4.604	54.768	69,979.575
20.° C.	8.021	4.149	32.311	57.118
22.° C.	6.080	1.208	02.369	27.176
25.° C.	2.828	27.957	69,952.189	876.996

APPARENT WEIGHT OF WATER AT 4.° C. (39.°2 F.) IN AIR AT 16.°67 C. (62.° F.)

(One cubic inch weighs 252.761 grains.

VOLUME.	Grams.	Grains.	Troy ounces.	Avoirdupois ounces.	Avoirdupois pounds.
Metric Measure.					
One Liter	999.512	15,424.831	32.1351	35.2568	2.20355
One Cubic-Centimeter	0.9995	15.425	0.0321	0.0353	
Wine Measure.					
One Gallon	3,783.466	58,387.855	121.6414	133.4580	8.34112
One Quart	945.896	14,596.964	30.0410	33.3645	2.08528
One Pint	472.933	7,298.482	15.2052	16.6822	1.04264
U. S. Apothecaries' Fluid Measure.					
One Fluidounce	29.5583	456.155	0.9503	1.0426	0.06516
One Fluidrachm	3.6948	57.019	0.1188	0.1303	
One Minim	0.0616	0.950	0.0020	0.0022	
Imperial Measure.					
One Gallon	4,540.820	70,075.500	145.9906	160.1723	10.01079
One Quart	1,135.205	17,518.875	36.4977	49.0431	2.50270
One Pint	567.602	8,759.438	18.2488	20.0215	1.25135
One Fluidounce	28.380	437.9719	0.9124	1.0011	0.06257
One Fluidrachm	3.5475	54.7465	0.1141	0.1251	
One Minim	0.0591	0.9124	0.0019	0.0021	

APPARENT WEIGHT OF WATER AT 15.°0 C. (59.° F.) IN AIR AT 16.°67 C. (62.° F.)

(One cubic inch weighs 252.554 grains.)

VOLUME.	Grams.	Grains.	Troy ounces.	Avoirdupois ounces.	Avoirdupois pounds.
Metric Measure.					
One Liter.....	998.695	15,412.215	32.1088	35.2279	2.20174
One Cubic-Centimeter	999	15.412	0.0321	0.0352	
Wine Measure.					
One Gallon.....	3,780.371	58,340.011	121.5417	133.3486	8.33429
One Quart.....	945.093	14,585.003	30.3854	33.3371	2.08357
One Pint.....	472.546	7,292.501	15.1927	16.6686	1.04179
U. S. Apothecaries' Fluid Measure.					
One Fluidounce.....	29.5341	455.781	0.9495	1.0418	0.06511
One Fluidrachm.....	3.6918	56.973	0.1187	0.1302	
One Minim.....	0.6153	0.9495	0.0020	0.0022	
Imperial Measure.					
One Gallon.....	4,537.199	70,018.111	145.8711	160.0414	10.00259
One Quart.....	1,134.200	17,504.528	36.4678	40.0103	2.50065
One Pint.....	567.100	8,752.264	18.2339	20.0052	1.25032
One Fluidrachm.....	28.355	437.613	0.9117	1.00026	0.06252
One Fluidounce.....	3.548	54.702	0.1140	0.12503	
One Minim.....	0.0591	0.9117	0.0019	0.00208	

APPARENT WEIGHT OF WATER AT 15.°56 C. (60.° F.) IN AIR AT 16.°67 C. (62.° F.)

(One cubic inch weighs 252.533 grains.)

VOLUME.	Grams.	Grains.	Troy ounces.	Avoirdupois ounces.	Avoirdupois pounds.
One Liter.....	998.613	15,410.949	32.1061	35.2250	2.20156
One Wine Gallon....	3,780.061	58,335.218	121.5317	133.3376	8.33360
One Wine Pint.....	472.508	7,291.902	15.1915	16.6672	1.04170
One U. S. Fluidounce	29.532	455.744	0.9495	1.0417	0.06511
One U. S. Minim....	0.0615	0.9495	0.00198	0.00217	
One Imp. Gallon....	4,536.722	70,012.289	145.8589	160.0281	10.00176
One Imp. Pint.....	567.090	8,751.536	18.2324	20.0035	1.25022
One Imp. Fluidounce	28.355	437.5768	0.9116	1.00018	0.06251
One Imp. Minim....	0.0591	0.9116	0.0019	0.00208	

APPARENT WEIGHT OF WATER AT 16°.67 C. (62° F.) IN AIR AT SAME TEMPERATURE.

(One cubic inch weighs 252.48843 grains.)

Volume.	Grams.	Grains.	Troy ounces.	Avoirdupois ounces.	Avoirdupois pounds.
One Liter.....	998.435	15,408.204	32.1004	35.2187	2.20117
One Wine Gallon....	3,779.387	58,324.827	121.5101	133.3139	8.33212
One Wine Pint.....	472.4234	7,290.6034	15.1888	16.6642	1.04151
One U. S. Fluid Oz..	29.5265	455.6627	0.9493	1.0415	0.06509
One U. S. Minim ...	0.0615	0.9493	0.00198	0.0022	
One Imp. Gallon ...	4,535.926	70,000.000	145.8333	160.00000	10 00000
One Imp. Pint.....	566.9907	8,750.000	18.2292	20.00000	1.25000
One Imp. Fluid Oz..	28.3495	437.500	0.9115	1.00000	0.0625
One Imp. Minim.....	0.0591	0.9115	0.00190	0.00208	

APPARENT WEIGHT OF WATER AT 22° C. (71°.6 F.) IN AIR AT 16°.67 C. (62° F.)

(One cubic inch weighs 252.226 grains.)

Volume.	Grams	Grains.	Troy ounces.	Avoirdupois ounces.	Avoirdupois pounds.
One Liter.....	997.397	15,392.188	32.0671	35.182	2.19888
One Wine Gallon....	3,775.459	58,264.201	121.3837	133.1525	8.32203
One Wine Pint.....	471.9324	7,283.025	15.1730	16.6441	1.04025
One U. S. Fluid Oz..	29.4958	455.1891	0.9483	1.0403	
One U. S. Minim....	0.06145	0.9483	0.00198	0.00217	
One Imp. Gallon....	4,531.208	69,927.176	145.6816	159.8335	9.98960
One Imp. Pint.....	566.401	8,740.897	18.2102	19.9792	1.24995
One Imp. Fluid Oz..	28.320	437.045	0.9105	0.99896	0.06250
One Imp. Minim....	0.0590	0.9105	0.0019	0.00208	

RELATIONS OF MEASURE TO WEIGHT AND OF WEIGHT TO MEASURE AT 22.°0 C. (71.°6 F.).*

PURE WATER.

The Liter.

1 Liter weighs 997.4 Grams.
1 " " 15,392 grains.
1 " " 32.07 Troy ounces.
1 " " 35.18 Avoirdupois ounces.
1 " " 2.199 " Pounds.

The Wine Gallon.

1 Wine Gallon weighs 3,775 Grams.
1 " " " 58,264 grains.
1 " " " 121.4 Troy Ounces.
1 " " " 133.2 Avoirdupois Ounces.
1 " " " 8.322 " Pounds.

The Wine Pint.

1 Wine Pint weighs 472 Grams.
1 " " " 7,283 grains.
1 " " " 15.173 Troy Ounces.
1 " " " 16.644 Avoirdupois Ounces.
1 " " " 1.0403 " Pounds.

The U. S. Fluidounce.

1 U. S. Fluidounce weighs 29.5 Grams.
1 " " " 455.19 grains.
1 " " " 0·95 Troy Ounce.
1 " " " 1.04 Avoirdupois Ounce.

* It is probable that this is the most common room temperature. These equivalents therefore are those which should be used for all ordinary practical purposes in pharmacy.

The U. S. Minim.

1 [illegible]. Minims weighs 61.45 Milligrams.
1 " " " 0.9483 grains.

The Imperial Gallon.

1 Imperial Gallon weighs 4.531 Grams.
1 " " " 69.927 grains.
1 " " " 159.8 Avoirdupois Ounces.
1 " " 0.10 " Pounds.
1 " " 145.7 Troy Ounces.

The Imperial Pint.

1 Imperial Pint weighs 566.4 Grams.
1 " " 8.740.9 grains.
1 " " " 19.98 Avoirdupois Ounces.
1 " " " 1.24905 " Pounds
1 " " " 18.210 Troy Ounces.

The Imperial Fluidounce.

1 Imperial Fluidounce weighs 28.32 Grams.
1 " " " 437 04 grains.
1 " " " 0.999 Avoirdupois Ounces.
1 " " " 0.911 Troy Ounces.

The Imperial Minim.

1 Imperial Minim weighs 59 Milligrams.
1 " " " 0.911 grain.

The Kilogram.

1 Kilogram measures 1,002.6 Cubic-centimeters.
1 " " 16,273 U. S. Minims.
1 " " 33.9 U. S. Fluidounces.
1 " " 16,949 Imperial Minims.
1 " " 35.31 Imperial Fluidounces.

The Avoirdupois Pound.

1 Avoirdupois Pound measures 454.777 Cubic-centimeters.
1 " " " 7,381 U. S. Minims.
1 " " " 15.378 U. S. Fluidounces.
1 " " " 0.96113 Wine Pint.
1 " " " 7,688 Imperial Minims.
1 " " " 16.017 " Fluidounces.
1 " " " 0.8008339 Imperial Pint.

The Avoirdupois Ounce.

1 Avoirdupois Ounce measures 28.423 Cubic-centimeters.
1 " " " 461.335 U. S. Minims.
1 " " " 0.96113 U. S. Fluidounce.
1 " " " 480.49 Imperial Minims.
1 " " " 1.0010 Imperial Fluidounce.

The Troy Ounce.

1 Troy Ounce measures 31.1846 Cubic-centimeters.
1 " " " 506 U. S. Minims.
1 " " " 1.5449 U. S. Fluidounce
1 " " " 527 Imperial Minims.
1 " " " 1.09828 Imperial Fluidounce.

The Grain.

1 Grain measures 0.06496 Cubic centimeters.
1 " " 1.05449 U. S. Minims.
1 " " 1.09828 Imp. Minims.

ALCOHOL AND DILUTED ALCOHOL.

Weight of given volumes of Official Alcohol at the temperature of 22.° C. (71.°6 F.)

1,000 Cubic-centimeters weighs 817 Grams.
1,000 " " " 12,608 grains.
1,000 " " " 20.267 Troy Ounces.
1,000 " " " 28.819 Avoirdupois Ounces.

1 Wine Pint weighs 5,966 grains.
1 " " " 12.429 Troy Ounces.
1 " " " 13.636 Avoirdupois Ounces.
1 " " " 386.6 Grams.

1 Imperial Pint weighs 7,160 grains.
1 " " " 16.366 Avoirdupois Ounces.
1 " " " 464 Grams.

100 U. S. Fluidounces weighs 37,286 grains.
100 " " " 77.679 Troy Ounces.
100 " " " 85.225 Avoirdupois Ounces.
100 " " " 2,416 Grams.

100 Imperial Fluidounces weighs 35,803 grains.
100 " " " 81.835 Avoirdupois Ounce.
100 " " " 2,320 Grams.

1,000 U. S. Minims weighs 776.79 grains.
1,000 " " " 50.33 Grams.
1,000 Imperial Minims weighs 745 90 grains.
1,000 " " " 48 33 Grams.

Volume of given quantities by weight of Official Alcohol at 22.° C. (71.°6. F.)

000 Grams measures 1,224 C.c
00 " " 19,867 U. S. Minims.
0 " " 20,691 Imperial Minims.
" " 41.390 U. S. Fluidounces.
" " 43.106 Imperial Fluidounces.

vois Pound measures 9,386 Imp. Minims.
" " 9,011 U. S. Minims.
" " 19.554 Imperial Fluidounces.
" " 18.773 U. S. Fluidounces.
" " 555 C.c.

100 Troy Ounces measures 61.791 U. S. Minims.
100 " " " 64,357 Imperial Minims.
100 " " " 128.731 U. S. Fluidounces.
100 " " " 134.078 Imperial Fluidounces.
100 " " " 3,807 C.c.

100 Avoirdupois Ounces measures 58,660 Imperial Minims.
100 " " " 56,322 U. S. Minims.
100 " " " 122.209 Imperial Fluidounces.
100 " " " 117.337 U. S. Fluidounces.
100 " " " 3,470 C.c.

1,000 grains measures 1,287 U. S. Minims.
1,000 " " 1,341 Imperial Minims.
1,000 " " 79.3125 C.c.

Weight of Given Volumes of Official Diluted Alcohol at the temperature of 22.° C. (71.°6 F)

1,000 Cubic-centimeters weighs 925 Grams.
1,000 " " " 14,274 grains.
1,000 " " " 29.738 Troy Ounces.
1,000 " " " 32.626 Avoirdupois Ounces.

1 Wine Pint weighs 6,759 grains.
1 " " " 14.081 Troy Ounces.
1 " " " 15.449 Avoirdupois Ounces.
1 " " " 438 Grams.

1 Imperial Pint weighs 8,102 grains.
1 " " " 18.519 Avoirdupois Ounces.
1 " " " 525 Grams.

100 U. S. Fluidounces weighs 42,207 grains.
100 " " " 87.932 Troy Ounces.
100 " " " 96.473 Avoirdupois Ounces.
100 " " " 2,735 Grams.

100 Imperial Fluidounces weighs 40,525 grains.
100 " " " 92.629 Avoirdupois Ounces.
100 " " " 2,626 Grams.

1,000 U. S. Minims weighs 879 grains.
1,000 " " " 56.98 Grams.

100 Imperial Minims weighs 144 grains.
100 " 54.72 Grams.

Volume and Gross Quantities by Weight of Official Diluted Alcohol at 22° C 71.96 F.

1 Cc. Gram measures 1.281 C.c.
1 " 17.547 U. S. Minims.
1 " 18.276 Imperial Minims.
1 " 30.493 U. S. Fluidounces.
1 " 38.275 Imperial Fluidounces.

1 Avoirdupois Pound measures 8.290 Imperial Minims.
1 " " 7.959 U. S. Fluidounces.
1 " " 17.271 Imperial Fluidounces.
1 " " 16.581 U. S. Fluidounces.
1 " " 490 C.c.

100 Troy Ounces measures 54.577 U. S. Minims.
100 " " 56,843 Imperial Minims.
100 " " 113.702 U. S. Fluidrachms.
100 " " 118.424 Imperial Fluidrachms.
100 " 3.363 C.c.

100 Avoirdupois Ounces measures 51,811 Imperial Minims.
100 " " " 49,745 U. S. Minims.
100 " " " 107.939 Imperial Fluidrachms.
100 " " " 103.635 U. S. Fluidrachms.
100 " " " 3,065 C.c.

1,000 grains measures 1,137 U. S. Minims.
1,000 " " 1,184 Imperial Minims.
1,000 " " 70.0625 C.c.

MISCELLANEOUS USEFUL DATA.

Weight of Air.

One cubic inch of air at 62.° F. of average humidity, and under 30 inches pressure weighs 0.307386258 grains.

One liter of air under the same conditions weighs 18.75836528 grains.

The volume of air displaced by a brass kilogram at 62.° F., under 30 inches pressure, weighs 2.20693 grains, and that displaced by a platinum kilogram 0.89328 grains.

Meters Reduced to Inches According to Clarke's Determination.

1	Meter	=	39.370432 Inches.
2	Meters	"	78.740864 "
3	"	"	118.111296 "
4	"	"	157.481728 "
5	"	"	196.852160 "
6	"	"	236.222592 "
7	"	"	275.593024 "
8	"	"	314.963456 "
9	"	"	354.333888 "
10	"	"	393.704320 "

Liters Reduced to Cubic Inches According to Clarke's Determination.

I	Liter	=	61.02538677 Cubic Inches.
2	Liters	"	122.05077354 " "
3	"	"	183.07616031 " "
4	"	"	244.10154708 " "

5	"	"	305.12693385	Cubic	Inches.
6	"	"	366.15232062	"	"
7	"	"	427.17770739	"	"
8	"	"	488.20309416	"	"
9	"	"	549.22848093	"	"
10	"	"	610.25386770	"	"

Kilograms of the Archives Reduced to Grains According to Miller's Determination.

1	Kilogram	=	15,432.34874	grains.
2	Kilograms	"	30,864.69748	"
3	"	"	46,297.04622	"
4	"	"	61,729.39496	"
5	"	"	77,161.74370	"
6	"	"	92,594.09244	"
7	"	"	108,026.44118	"
8	"	"	123,458.78992	"
9	"	"	138,891.13866	"
10	"	"	154,323.48740	"

Grains Reduced to Milligrams According to Miller's Determination.

1	Grain	=	64.79895 Milligrams.
	Grains	"	129.59790 "
	"	"	194.39685 "
		"	259.19580 "
		"	323.99475 "
		"	388.79370 "
			453.59265 "
			518.39160 "
			583.19055 "
			647.98950 "

TABLE OF THERMOMETRIC EQUIVALENTS.

Fahrenheit and Centigrade Scales.

To reduce Centigrade degrees to those of Fahrenheit:
Multiply by 9, divide by 5, and add 32.

To reduce Fahrenheit's degrees to those of the Centigrade scale:
Subtract 32, multiply by 5, and divide by 9.

TABLE OF EQUIVALENTS.

Fahrenheit.	Centigrade or Celsius.	Fahrenheit.	Centigrade or Celsius.	Fahrenheit.	Centigrade or Celsius.	Fahrenheit.	Centigrade or Celsius.	Fahrenheit	Centigrade or Celsius.
500	260	199.4	93	132.8	56	98	36.66	73	22.78
446	230	200	93.33	131	55	97	36.11	72	22.22
410	210	197.6	92	129.2	54	96.8	36	71.6	22
392	200	195.8	91	127.4	53	96	35.55	71	21.67
374	190	194	90	125.6	52	95	35	70	21.11
365	185	192.2	89	123.8	51	94	34.44	69.8	21
356	180	190.4	88	122	50	93.2	34	69	20.56
347	175	188.6	87	120.2	49	93	33.88	68	20
338	170	186.8	86	118.4	48	92	33.33	67	19.44
329	165	185	85	116.6	47	91.4	33	66.2	19
320	160	183.2	84	116	46.66	91	32.77	66	18.89
311	155	181.4	83	115	46.11	90.5	32.50	65	18.33
302	150	179.6	82	114.8	46	90	32.22	64.4	18
300	148.88	177.8	81	114	45.55	89.6	32	64	17.78
293	145	176.	80	113	45	89	31.66	63	17.22
284	140	174.2	79	112	44.44	88	31.11	62.6	17
275	135	172.4	78	111.2	44	87.8	31	62	16.67
266	130	170.6	77	111	43.88	87	30.55	61	16.11
257	125	168.8	76	110	43.33	86	30	60.8	16
248	120	167	75	109.4	43	85	29.44	60	15.56
239	115	165.2	74	109	42.77	84.2	29	59	15
230	110	163.4	73	108.5	42.50	84	28.88	58	14.44
228.2	109	161.6	72	108	42.22	83	28.33	57.2	14
226.4	108	159.8	71	107.6	42	82.4	28	57	13.89
224.6	107	158	70	107	41.66	82	27.77	56	13 33
222.8	106	156.2	69	106	41.11	81.5	27.50	55.4	13
221	105	154.4	68	105.8	41	81	27.22	55	12.78
219.2	104	152.6	67	105	40.55	80.6	27	54	12.22
217.4	103	150.8	66	104	40	80	26.66	53.6	12
215.6	102	149	65	103	39.46	79	26.11	53	11.67
213.8	101	147.2	64	102.2	39	78.8	26	52	11.11
212	100	145.4	63	102	38.88	78	25.55	51.8	11
210.2	99	143.6	62	101	38.33	77	25	51	10.56
208.4	98	141.8	61	100.4	38	76	24.44	50	10
206.6	97	140	60	100	37.77	75.2	24	49	9.44
204.8	96	138.2	59	99.5	37.50	75	23.88	48.2	9
203.	95	136.4	58	99	37.22	74	23.33	48	8.89
201.2	94	134.6	57	98.6	37	73.4	23	47	8.

[illegible]—continued.

Fahrenheit	Centigrade or Celsius	Fahrenheit	Centigrade or Celsius	Fahrenheit	Centigrade or Celsius	Fahrenheit	Centigrade or Celsius	Fahrenheit	Centigrade or Celsius
46.4	8	36	2.22	26	-3.33	5	-15	-20.2	-29
46	7.78	35.6	2	25	-3.89	3.2	-16	-22	-30
45	7.22	35	1.67	24.8	4	1.4	-17	-23.8	-31
44.6	7	34	1.11	24	-4.44	0	-17.78	-25.6	-32
44	6.67	33.8	1	23	-5	-0.4	-18	-27.4	-33
43	6.11	33	0.56	22	-5.56	-2.2	-19	-29.2	-34
42.8	6	32	0	21.2	-6	-4	-20	-31	-35
42	5.56	31	-0.56	19.4	-7	-5.8	-21	-32.8	-36
41	5	30.2	1	17.6	-8	-7.6	-22	-34.6	-37
40	4.44	30	1.11	15.8	9	-9.4	-23	-36.4	-38
39.2	4	29	1.67	14	10	-11.2	-24	-38.2	-39
39	3.89	28.4	-2	12.2	-11	-13.	-25	-40.	-40
38	3.33	28	2.22	10.4	-12	-14.8	-26		
37.4	3	27	2.78	8.6	-13	-16.6	-27		
37	2.78	26.6	3	6.8	14	-18.4	-28		

TABLES OF EQUIVALENTS.

These tables are believed to be entirely accurate, the equivalents given being much nearer exactness than will probably be required for any medical or pharmacal purposes.

For approximate equivalents, see pages 68 to 72 and 103 to 105.

ENGLISH LONG MEASURE CONVERTED INTO METRIC.

TABLE I.

Miles in Meters.

(1 Mile of 5,280 feet = 1609.329533 Meters.)

1/16	Mile	=	100.583 Meters.	4	Miles	=	6,437.318 Meters.
1/8	"	"	201.166 "	5	"	"	8,046.648 "
1/4	"	"	402.332 "	6	"	"	9,655.978 "
1/2	"	"	804.665 "	7	"	"	11,265.307 "
1	"	"	1,609.330 "	8	"	"	12,874.636 "
2	Miles	"	3,218.659 "	9	"	"	14,483.961 "
3	"	"	4,827.989 "	10	"	"	16,093.295 "

TABLE II.

Yards in Meters.

(1 Yard = 0.91439178 Meter.)

1	Yard	=	0.914 Meter.	6	Yards	=	5 486 Meters.
2	Yards	"	1.829 Meters.	7	"	"	6.401 "
3	"	"	2.743 "	8	"	"	7.315 "
4	"	"	3.658 "	9	"	"	8.230 "
5	"	"	4.572 "	10	"	"	9.144 "

TABLE III.

Feet in Meters.

(1 Foot = 0.304797 Meter.)

1 Foot	=	30.48	Centimeters.	6 Feet	=	1.83	Meters.
2 Feet	=	60.96	"	7 "	"	2.13	"
3 "	=	91.44	"	8 "	"	2.44	"
4 "	=	1.22	Meters.	9 "	"	2.74	"
5 "	=	1.52	"	10 "	"	3.05	"

TABLE IV.

Inches in Meters.

(1 Inch = 0.02539977 Meter.)

1/1000 Inch	=	0.025	Millimeter.	4 Inches	=	10.16	Centimeters.
1/100	=	0.253	"	5 "	"	12.70	"
1/50	=	0.508	"	6 "	"	15.24	"
1/40	=	0.634	"	7 "	"	17.78	"
1/30	=	0.846	"	8 "	"	20.32	"
1/25	=	1.015	"	9 "	"	22.86	"
1/20	=	1.270	"	10 "	"	25.40	"
1/15	=	1.693	"	11 "	"	27.94	"
1/12	=	2.116	"	12 "	"	30.48	"
1/10	=	2.539	"	13 "	"	33.02	"
1/9	=	2.822	"	14 "	"	35.56	"
1/8	=	3.175	"	15 "	"	38.10	"
1/7	=	3.628	"	16 "	"	40.64	"
1/6	=	4.233	"	17 "	"	43.18	"
1/5	=	5.080	"	18 "	"	45.72	"
1/4	=	6.350	"	19 "	"	48.26	"
1/3	=	8.466	Millimeters.	20 "	"	50.80	"
1/2	=	12.700	"	30 "	"	76.20	"
2/3	=	16.933	"	40 "	"	101.60	"

METRIC LONG MEASURE CONVERTED INTO ENGLISH.

TABLE V.

Meters in Miles.

(Kilometer = 0.621376768 Mile.)

1 Kilometer	=	0.621	Mile.	6 Kilometers	=	3.728	Miles.
2 Kilometers	=	1.243	Miles.	7 "	"	4.350	"
3 "	=	1.864	"	8 "	"	4.971	"
4 "	=	2.485	"	9 "	"	5.592	"
5 "	=	3.107	"	10 "	"	6.214	"

TABLE VI.

Meters in Yards.

(1 Meter = 1.093623 Yards.)

1 Meter	=	1.094	Yards.	6 Meters	=	6.562	Yards.
2 Meters	"	2.187	"	7 "	"	7.655	"
3 "	"	3.281	"	8 "	"	8.749	"
4 "	"	4.374	"	9 "	"	9 843	"
5 "	"	5.468	"	10 "	"	10.936	"

TABLE VII.

Meters in Feet.

(1 Meter = 3.280869 Feet)

1 Meter	=	3.281	Feet.	6 Meters	=	19.685	Feet.
2 Meters	"	6.562	"	7 "	"	22.966	"
3 "	"	9.843	"	8 "	"	26.247	"
4 "	"	13.123	"	9 "	"	29.528	"
5 "	"	16.404	"	10 "	"	32.809	"

TABLE VIII.

Meters in Inches.

(1 Meter = 39.370432 Inches.)

1 Millimeter	=	0.039	Inch.	5 Meters	=	196.852	Inches.
1 Centimeter	"	0.394	"	6 "	"	236.223	"
1 Decimeter	"	3.937	Inches.	7 "	"	275.593	"
1 Meter	"	39.370	"	8 "	"	314.963	"
2 Meters	"	78.741	"	9 "	"	354.334	"
3 "	"	118.111	"	10 "	"	393.704	"
4 "	"	157.482	"				

TABLE IX.

Meters in Feet and Inches.

(1 Meter = 39.370432 Inches.)

1 Meter	=	3	Ft. and	3.4	Inches.	6 Meters	=	19	Ft. and	8.2	Inches.
2 Meters	"	6	"	6.8	"	7 "	"	22	"	11.6	"
3 "	"	9	"	9.1	"	8 "	"	26	"	3.0	"
4 "	"	13	"	1.5	"	9 "	"	29	"	6.3	"
5 "	"	16	"	4.8	"	10 "	"	32	"	9.7	"

ENGLISH SQUARE MEASURE CONVERTED INTO METRIC.

TABLE X.

Square Miles in Square Kilometers.

1 Sq. Mile	= 2.59	Sq. Kilometers.	6 Sq. Miles	= 15.54	Sq. Kilometers.
2 " " "	5.18	" "	7 " " "	18.13	" "
3 " " "	7.77	" "	8 " " "	20.72	" "
4 " " "	10.36	" "	9 " " "	23.31	" "
5 " " "	12.95	" "	10 " " "	25.90	" "

TABLE XI.

Square Yards in Square Meters (Centares.)

1 Sq. Yard	= 0.836	Sq. Meter.	6 Sq. Yards	= 5.017	Sq. Meters.
2 Sq. Yards	" 1.672	Sq. Meters.	7 " " "	5.853	" "
3 " " "	2.508	" "	8 " " "	6.689	" "
4 " " "	3.345	" "	9 " " "	7.525	" "
5 " " "	4.181	" "	10 " " "	8.361	" "

TABLE XII.

Square Feet in Square Meters (Centares.)

(1 Square Foot = 0.092903 Square Meter.)

1 Sq. Foot	= 0.093	Sq. Meter.	6 Sq. Feet	= 0.557	Sq. Meter.
2 Sq. Feet	" 0.186	" "	7 " " "	0.650	" "
3 " "	0.279	" "	8 " " "	0.743	" "
4 " "	0.372	" "	9 " " "	0.836	" "
5 " "	0.464	" "	10 " " "	0.929	" "

TABLE XIII.

Square Inches in Square Centimeters.

]q. Inch	= 6.45	Sq. Centimeters.	6 Sq. In's	= 38.71	Sq. Centimeters.
q. Inches	" 12.90	" "	7 " " "	45 16	" "
"	" 19.35	" "	8 " " "	51.61	" "
"	" 25.81	" "	9 " " "	58.06	" "
"	" 32.26	" "	10 " " "	64.52	" "

METRIC SQUARE MEASURE CONVERTED INTO ENGLISH.

TABLE XIV.

Square Kilometers in Square Miles.

(1 Square Kilometer = 0.3861 Square Mile.)

1 Sq. Kilometer	= 0.386 Sq. Mile.	6 Sq. Kilometers	= 2.317 Sq. Miles
2 Sq. Kilometers	" 0.772 "	7 " "	" 2.703 " "
3 " "	" 1.158 "	8 " "	" 3.089 " "
4 " "	" 1.544 "	9 " "	" 3.475 " "
5 " "	" 1.931 "	10 " "	" 3.861 " "

TABLE XV.

Square Meters Centares in Square Yards.

1 Square Meter	= 1.196 Sq. Yards	6 Sq. Meters	= 7.176 Sq. Yds.
2 Square Meters	= 2.392 " "	7 " "	" 8.372 " "
3 " "	" 3.588 " "	8 " "	" 9.568 " "
4 " "	" 4.784 " "	9 " "	" 10.764 " "
5 " "	" 5.980 " "	10 " "	" 11.960 " "

TABLE XVI.

Square Meters (Centares) in Square Feet.

1 Square Meter	= 10.76 Sq. Feet.	6 Square Meters	= 64.58 Sq. Ft.
2 Square Meters	= 21.53 " "	7 " "	" 75.35 " "
3 " "	" 32.29 " "	8 " "	" 86.11 " "
4 " "	" 43.06 " "	9 " "	" 96.87 " "
5 " "	" 53.82 " "	10 " "	" 107.64 " "

TABLE XVII.

Square Meters (Centares) in Square Inches.

(1 Square Meter = 1,550.03091587 Square Inches.)

1 Sq. Meter	= 1,550 Sq. Inches.	6 Sq. Meters	= 9,300 Sq. Inchs.
2 Sq. Meters	" 3,100 " "	7 " "	" 10,850 " "
3 " "	" 4,650 " "	8 " "	" 12,400 " "
4 " "	" 6,200 " "	9 " "	" 13,950 " "
5 " "	" 7,750 " "	10 " "	" 15,500 " "

ENGLISH LAND MEASURE CONVERTED INTO METRIC.

TABLE XVIII.

Acres in Ares.

(1 Acre = 40.469 Are.)

1 Acre	=	40.469	Ares.	6 Acres	=	2,428	Hektares
2 Acres	"	80.938	"	7 "	"	2.833	"
3 "	"	1.214	Hektares.	8 "	"	3.237	"
4 "	"	1.619	"	9 "	"	3.642	"
5 "	"	2.023	"	10 "	"	4.047	"

METRIC LAND MEASURE CONVERTED INTO ENGLISH.

TABLE XIX.

Ares in Acres.

(1 Are = 0.02471 Acre.)

1 Are	=	0.02471	Acre.	5 Hectares	=	12.355	Acres.
10 Ares	"	0.2471	"	6 "	"	14.826	"
1 Hektare	=	2.471	Acres.	7 "	"	27.297	"
2 Hektares	"	4.942	"	8 "	"	19.768	"
3 "	"	7.413	"	9 "	"	22.239	"
4 "	"	9.884	"	10 "	"	24.710	"

ENGLISH CUBIC MEASURE CONVERTED INTO METRIC.

TABLE XX.

Cubic Yards in Cubic Meters (Steres).

1 Cubic Yard	=	0.765	Cubic Meter.	6 Cubic Yards	=	4,587	Cubic-Meters
2 Cubic Yards	"	1.529	Cubic-Meters	7 " "	"	5.352	"
3 " "	"	2.294	"	8 " "	"	6.116	"
4 " "	"	3.058	"	9 " "	"	6.881	"
5 " "	"	3.823	"	10 " "	"	7.646	"

Cubic Feet in Liters (Cubic-decimeters).

TABLE XXI.

1 Cubic Foot	=	28.32	Liters.	6 Cubic Feet	=	169.90	Liters
2 Cubic Feet	"	56.63	"	7 " "	"	198.22	"
3 " "	"	84.95	"	8 " "	"	226.54	"
4 " "	"	113.27	"	9 " "	"	254.85	"
5 " "	"	141.59	"	10 " "	"	283.17	"

TABLE XXII.

Cubic Inches in Cubic-centimeters (or Fluigrams.

(1 Cubic-Inch = 16.386623 Cubic-centimeters.

1	Cubic Inch	=	16.4	C.c.	16	Cubic Inches =	262 2 C.c.
2	Cubic Inches	"	32.8	"	17	" " "	278.6 "
3	" "	"	49.2	"	18	" " "	295 0 "
4	" "	"	65.5	"	19	" " "	311.4 "
5	" "	"	81.9	"	20	" " "	327.7 "
6	" "	"	98.3	"	25	" " "	409.7 "
7	" "	"	114.7	"	30	" " "	491.6 "
8	" "	"	131.1	"	35	" " "	573.6 "
9	" "	"	147.5	"	40	" " "	655.5 "
10	" "	"	163.0	"	50	" " "	819.4 "
11	" "	"	180.3	"	60	" " "	983.2 "
12	" "	"	196.6	"	70	" " "	1147.1 "
13	" "	"	213.0	"	80	" " "	1311.0 "
14	" "	"	229.4	"	90	" " "	1474.8 "
15	" "	"	245.8	"	100	" " "	1638.66 "

METRIC CUBIC MEASURES CONVERTED INTO ENGLISH

TABLE XXIII.

Cubic Meters (Steres) in Cubic Yards.

1	Cubic Meter	=	1.308	Cubic Yds.	6	Cubic Meters =	7.848 Cubic Yds.
2	Cubic Meters	"	2.616	" "	7	" " "	9.156 " "
3	" "	"	3.924	" "	8	" " "	10.464 " "
4	" "	"	5.232	" "	9	" " "	11.771 " "
5	" "	"	6.540	" "	10	" " "	13.079 " "

TABLE XXIV.

Cubic Meters (Steres) in Cubic Feet.

1	Cubic Meter	=	35.31	Cubic Ft.	6	Cubic Meters =	211.88 Cubic Ft.
2	Cubic Meters	"	70.63	" "	7	" " "	247.20 " "
3	" "	"	105.94	" "	8	" " "	282.52 " "
4	" "	"	141.26	" "	9	" " "	317.83 " "
5	" "	"	176.57	" "	10	" " "	353.14 " "

TABLE XXV.

Liters in Cubic Inches.

(1 Liter = 61.025387 Cubic Inches.)

1	Liter	=	61.025	Cubic Inches.		6	Liters	=	366.152	Cubic Inches.	
2	Liters	"	122.051	"	"	7	"	"	427.177	"	"
3	"	"	183 076	"	"	8	"	"	488.203	"	"
4	"	"	244.101	"	"	9	"	"	549.228	"	"
5	"	"	305.127	"	"	10	"	"	610.254	"	"

ENGLISH BUSHELS CONVERTED INTO LITERS.

TABLE XXVI.

Bushels in Liters.

1	Bushel	=	35.2	Liters.	6	Bushels	=	211.4	Liters.
2	Bushels	"	70.5	"	7	"	"	246.7	"
3	"	"	105.7	"	8	"	"	281 9	"
4	"	"	141.0	"	9	"	"	317.2	"
5	"	"	176.2	"	10	"	"	352.4	"

METRIC DRY MEASURE CONVERTED INTO BUSHELS.

TABLE XXVII.

Steres (Cubic Meters) in Bushels.

1	Stère	=	28.4	Bushels.	6	Stères	=	170.3	Bushels.
2	Stères	"	56.8	"	7	"	"	198.6	"
3	"	"	85.1	"	8	"	"	227.0	"
4	"	"	113.5	"	9	"	"	255.4	"
5	"	"	141.9	"	10	"	"	283.8	"

WINE MEASURE CONVERTED INTO METRIC.

TABLE XXVIII.

Wine Gallons in Liters.

(1 Wine Gallon = 3.785309889 Liters.)

1	Wine Gallon	=	3.785	Liters.	6	Wine Gallons	=	22.713	Liters
2	Wine Gallons	"	7.571	"	7	"	"	26.498	"
3	"	"	11.356	"	8	"	"	30.283	"
4	"	"	15.141	"	9	"	"	34 069	"
5	"	"	18.927	"	10	"	"	37.853	"

TABLE XXIX.

Wine Quarts in Liters.

(1 Wine Quart = 946.327472 Cubic-centimeters.)

1	Wine Quart	=	946 Milliliters.	6	Wine Quarts	=	5.678 Liters.
2	Wine Quarts	"	1.893 Liters.	7	" " "		6.625 "
3	" "	"	2.839 "	8	" " "		7.571 "
4	" "	"	3.785 "	9	" " "		8.517 "
5	" "	"	4.732 "	10	" " "		9.464 "

TABLE XXX.

Wine Pints in Liters.

(1 Wine Pint = 473.163736 Cubic-centimeters.)

1	Wine Pint	=	0.473 Liters.	15	Wine Pints	=	7.097 Liters
2	Wine Pints	"	0.946 "	16	" " "		7.571 "
3	" "	"	1.419 "	17	" " "		8.044 "
4	" "	"	1.893 "	18	" " "		8.517 "
5	" "	"	2.366 "	19	" " "		8.990 "
6	" "	"	2.839 "	20	" " "		9.463 "
7	" "	"	3.312 "	30	" " "		14.195 "
8	" "	"	3.785 "	40	" " "		18.927 "
9	" "	"	4.258 "	50	" " "		23.658 "
10	" "	"	4.732 "	60	" " "		28.399 "
11	" "	"	5.205 "	70	" " "		33.121 "
12	" "	"	5.678 "	80	" " "		37.853 "
13	" "	"	6.151 "	90	" " "		42.585 "
14	" "	"	6.624 "	100	" " "		47.316 "

U. S. APOTHECARIES' FLUID MEASURE CONVERTED INTO METRIC.

TABLE XXXI.

U. S. Fluidounces in Cubic-centimeters (or Fluigrams).

(1 U. S. Fluidounce = 29.572734 Cubic centimeters).

⅛	U. S. Fluidounce	=	3.70 C.c.	4	U.S. Fluidounces	=	118.29 C.c.
¼	" "	"	7.39 "	5	" "	"	147.86 "
½	" "	"	14.79 "	6	" "	"	177.44 "
1	" "	"	29.57 "	7	" "	"	207.009 "
2	" Fluidounces	"	59.10 "	8	" "	"	236.58 "
3	" "	"	88.72 "	9	" "	"	266.15 "

10	U. S. Fluidounces	=	295.73	C.c.	32	U. S. Fluidounces	=	946.33 C.c.
11	" " "		325.30	"	33	" " "		975.90 "
12	" " "		354.87	"	34	" " "		1005.47 "
13	" " "		384.45	"	35	" " "		1035.05 "
14	" " "		414.02	"	36	" " "		1064 62 "
15	" " "		443.59	"	37	" " "		1094.19 "
16	" " "		473.16	"	38	" " "		1123.76 "
17	" " "		502.74	"	39	" " "		1153.34 "
18	" " "		532.31	"	40	" " "		1182.91 "
19	" " "		561.88	"	41	" " "		1212.48 "
20	" " "		591 45	"	42	" " "		1242.05 "
21	" " "		621.02	"	43	" " "		1271.63 "
22	" " "		650.60	"	44	" " "		1301.20 "
23	" " "		680.17	"	45	" " "		1330.77 "
24	" " "		709.75	"	46	" " "		1360.36 "
25	" " "		739.32	"	47	" " "		1389.86 "
26	" " "		768.89	"	48	" " "		1419.49 "
27	" " "		798.46	"	49	" " "		1449.06 "
28	" " "		828.04	"	50	" " "		1478.64 "
29	" " "		857.61	"	60	" " "		1774.36 "
30	" " "		887.18	"	64	" " "		1892.65 "
31	" " "		916.75	"	128	" " "		3785.31 "

TABLE XXXII.

U. S. Fluidrachms in Cubic-centimeters (or Fluigrams).

(1 U. S. Fluidrachm = 3.696592 Cubic-centimeters.)

1	U. S. Fluidrachm	=	3.70	C.c.	14	U. S. Fluidrachms	=	51.75 C.c.
2	" Fluidrachms	"	7.39	"	15	" " "		55.45 "
3	" "	"	11.09	"	16	" " "		59.10 "
4	" "	"	14.79	"	17	" " "		62.80 "
5	" "	"	18.48	"	18	" " "		66.54 "
6	" "	"	22.18	"	19	" " "		70.24 "
7	" "	"	25.88	"	20	" " "		73.93 "
8	" "	"	29.57	"	21	" " "		77.63 "
9	" "	"	23 27	"	22	" " "		81.32 "
10	" "	"	36 97	"	23	" " "		85.02 "
11	" "	"	40.66	"	24	" " "		88.72 "
12	" "	"	44.36	"	25	" " "		92.41 "
13	" "	"	48.06	"	30	" " "		110.90 "

TABLE XXXIII.

U. S. Minims in Cubic-centimeters (or Fluigrams).

(1 U. S. Minim = 0.0616086 Cubic-centimeters.

½	U. S. Minim =	0.03	C.c.
1	" " " =	0.06	"
1½	" " " =	0.09	"
2	" Minims " =	0.12	"
3	" " " =	0.18	"
4	" " " =	0.25	"
5	" " " =	0.31	"
6	" " " =	0 37	"
7	" " " =	0.43	"
8	" " " =	0.49	"
9	" " " =	0 55	"
10	" " " =	0.62	"
11	" " " =	0.68	"
12	" " " =	0.74	"
13	" " " =	0.80	"
14	" " " =	0.86	"
15	" " " =	0.92	"
16	U. S. Minims =	0.99	C.c.
17	" " " =	1.05	"
18	" " " =	1.11	"
19	" " " =	1.17	"
20	" " " =	1.23	"
25	" " " =	1.54	"
30	" " " =	1.85	"
35	" " " =	2.15	"
40	" " " =	2.46	"
45	" " " =	2.77	"
50	" " " =	3.08	"
55	" " " =	3.39	"
60	" " " =	3.70	"
70	" " " =	4.31	"
80	" " " =	4.93	"
90	" " " =	5.54	"
100	" " " =	6.16	"

METRIC MEASURES OF CAPACITY CONVERTED INTO ENGLISH WINE MEASURE.

TABLE XXXIV.

Liters in Wine Gallons.

(1 Liter = 0.264179 Gallon.)

1 Liter =	0.264	Wine Gallon.		
2 Liters "	0.528	"	"	
3 " "	0.793	"	"	
4 " "	1.057	Wine Gallons.		
5 " "	1.321	"	"	
6 " "	1.585	"	"	
7 " "	1.849	"	"	
8 " "	2.113	"	"	
9 " "	2.377	"	"	
10 " "	2.642	"	"	
20 Liters =	5.283	Wine Gallons.		
30 " "	7.925	"	"	
40 " "	10.567	"	"	
50 " "	13.209	"	"	
60 " "	15.850	"	"	
70 " "	18.492	"	"	
80 " "	21.134	"	"	
90 " "	23.775	"	"	
100 " "	26.418	"	"	

TABLE XXXV.

Liters in Wine Quarts.

(1 Liter = 0.56717 Wine Quarts.)

1	Liter	=	1.057	Wine	Quarts.	6	Liters =	6.340	Wine Quarts.
2	Liters	"	2.113	"	"	7	" "	7.397	" "
3	"	"	3.170	"	"	8	" "	8.454	" "
4	"	"	4.227	"	"	9	" "	9.510	" "
5	"	"	5.283	"	"	10	" "	10.567	" "

TABLE XXXVI.

Liters in Wine Pints.

(1 Liter = 2.113433 Wine Pints.)

1	Liter	=	2.113	Wine	Pints.	9	Liters =	19.020	Wine Pints.
2	Liters	"	4.227	"	"	10	" "	21.134	" "
3	"	"	6.340	"	"	20	" "	42.269	" "
4	"	"	8.454	"	"	30	" "	63.403	" "
5	"	"	10.567	"	"	40	" "	84.537	" "
6	"	"	12.680	"	"	50	" "	105.672	" "
7	"	"	14,794	"		100	" "	211.343	" "
8	"	"	16.907	"	"				

METRIC MEASURES CONVERTED INTO U. S. APOTHECARIES' FLUID MEASURE.

TABLE XXXVII.

Liters in U. S. Fluidounces.

(1 Liter = 33.814933 U. S. Fluidounces.)

1	Liter	=	33.815	U.S.	Fluidounces.	6	Liters=	202.890	U.S. Fluidounces
2	Liters	"	97.630	"	"	7	" "	236.705	" "
3	"	"	101.445	"	"	8	" "	270.519	" "
4	"	"	135.260	"	"	9	" "	304.335	" "
5	"	"	169.075	"	"	10	" "	338.149	"

TABLE XXXVIII.

Cubic-centimeters (or Fluigrams) in U. S. Fluidounces.

(1,000 Cubic-centimeters = 33,814933 U. S. Fluidounces.)

1	Fluigram	=	0.034	U. S.	Fluid	oz.	40	Fluigrams	=	1.352 U.S. Fl.oz.
2	Fluigrams	"	0.068	"	"		45	"	"	1.521 " "
3	"	"	0.101	"	"		50	"	"	1.690 " "
4	"	"	0.135	"	"		55	"	"	1.859 " "
5	"	"	0.169	"	"		60	"	"	2.029 " "
6	"	"	0.203	"	"		65	"	"	2.198 " "
7	"	"	0.237	"	"		70	"	"	2.362 " "
8	"	"	0.271	"	"		75	"	"	2.536 " "
9	"	"	0.304	"	"		80	"	"	2.705 " "
10	"	"	0.338	"	"		85	"	"	2.874 " "
11	"	"	0.371	"	"		90	"	"	3.043 " "
12	"	"	0.406	"	"		95	"	"	3 212 " "
13	"	"	0.440	"	"		100	"	"	3.381 " "
14	"	"	0.473	"	"		200	"	"	6.752 " "
15	"	"	0.507	"	"		300	"	"	10.143 " "
16	"	"	0.541	"	"		400	"	"	13,526 " "
17	"	"	0.575	"	"		500	"	"	16.905 " "
18	"	"	0.608	"	"		600	"	"	20.288 " "
19	"	"	0.642	"	"		700	"	"	23.670 " "
20	"	"	0.676	"	"		800	"	"	27.051 " "
30	"	"	1.014	"	"		900	"	"	30.432 " "
35	"	"	1.184	"	"		1000	"	"	33.815 " "

TABLE XXXIX

Cubic-centimeters (or Fluigrams) in U. S. Fluidrachms.

(1 Cubic-centimeter, or fluigram =0.270519463 U. S. Fluidrachms.)

1	C.c.	=	.27	U. S.	Fluidrachms.		12	C.c	= 3.25	U. S. Fluidrachms.
2	"	"	.54	"	"		13	"	" 3.52	" "
3	"	"	.81	"	"		14	"	" 3.79	" "
4	"	"	1.08	"	"		15	"	" 4.06	" "
5	"	"	1.35	"	"		16	"	" 4.33	" "
6	"	"	1.62	"	"		17	"	" 4.60	" "
7	"	"	1.89	"	"		18	"	" 4.87	" "
8	"	"	2.16	"	"		19	"	" 5.14	" "
9	"	"	2.43	"	"		20	"	" 5.41	" "
10	"	"	2.70	"	"		21	"	" 5.68	" "
11	"	"	2.98	"	"		22	"	" 5.95	" "

23	C.c.	=	6.22	U. S.	Fluidrachms.	36	C.c.	=	9.74 U.S. Fluidrachms.
24	"	"	6.49	"	"	37	"	"	10.01 " "
25	"	"	6.76	"	"	38	"	"	10.28 " "
26	"	"	7.03	"	"	39	"	"	10.55 " "
27	"	"	7.30	"	"	40	"	"	10.82 " "
28	"	"	7.57	"	"	45	"	"	12.17 " "
29	"	"	7.84	"	"	50	"	"	13.52 " "
30	"	"	8.12	"	"	60	"	"	16.23 " "
31	"	"	8.39	"	"	70	"	"	18.94 " "
32	"	"	8.66	"	"	80	"	"	21.64 " "
33	"	"	8.93	"	"	90	"	"	24.35 " "
34	"	"	9.20	"	"	100	"	"	27.05 " "
35	"	"	9.47	"	"				

TABLE XL.

Cubic-centimeters (or Fluigrams) in U. S. Minims.

(1 Cubic-centimeter = 16.2311678 U. S. Minims.)

0.01	Fluigram	=	0.16	U.S.	Minims	5	Fluigrams	=	81.16 U.S. Minims
0.02	"	"	0.18	"	"	6	"	"	97.39 " "
0.03	"	"	0.49	"	"	7	"	"	113.62 " "
0.04	"	"	0.65	"	"	8	"	"	129.85 " "
0.05	"	"	0.81	"	"	9	"	"	146.08 " "
0.06	"	"	0.97	"	"	10	"	"	162.31 " "
0.07	"	"	1.14	"	"	11	"	"	178.54 " "
0.08	"	"	1.30	"	"	12	"	"	194 77 " "
0.09	"	"	1.46	"	"	13	"	"	211.00 " "
0.10	"	"	1.62	"	"	14	"	"	227.23 " "
0.15	"	"	2.43	"	"	15	"	"	243.46 " "
0.20	"	"	3.25	"	"	16	"	"	259.69 " "
0.25	"	"	4.06	"	"	17	"	"	275.92 " "
0.30	"	"	4.87	"	"	18	"	"	292 15 " "
0.35	"	"	5.68	"	"	19	"	"	308.38 " "
0.40	"	"	6.49	"	"	20	"	"	324.62 " "
0.50	"	"	8.12	"	"	30	"	"	486.93 " "
0.60	"	"	9.74	"	"	40	"	"	648.24 " "
0.70	"	"	11.36	"	"	50	"	"	811.56 " "
0.80	"	"	12.98	"	"	60	"	"	973.87 " "
0.90	"	"	14.61	"	"	70	"	"	1,136.18 " "
1.00	"	"	16.23	"	"	80	"	"	1,298.49 " "
2	"	"	32.46	"	"	90	"	"	1,460.80 " "
3	"	"	48.69	"	"	100	"	"	1,623.12 " "
4	"	"	64.92	"	"				

TABLE XLI.

Cubic centimeters (or Fluigrams) in U. S. Pints, Fluidounces, Fluidrachms and Minims.

1,000 C.c. = 2 pints, 1 fl. oz., 6 fl. drs. and 30 minims.
900 " " 1 pint, 14 fl. ozs., 3 fl. drs. and 30 minims.
800 " " 1 pint, 11 fl. ozs. and 24 minims.
700 " " 1 pint, 7 fl. ozs., 5 fl. drs. and 21 minims.
600 " " 1 pint, 4 fl. ozs., 2 fl. drs. and 18 minims.
500 " " 1 pint, 7 fl. drs. and 16 minims.
400 " " 13 fl. ozs., 4 fl. drs. and 13 minims.
300 " " 10 fl. ozs. and 70 minims.
200 " " 6 fl. ozs., 6 fl. drs. and 7 minims.
100 " " 3 fl. ozs., 3 fl. drs. and 3 minims.
90 " " 3 fl. ozs. and 21 minims.
80 " " 2 fl. ozs., 5 fl. drs. and 40 minims.
70 " " 2 fl. ozs., 2 fl. drs. and 57 minims.
60 " " 2 fl. ozs, and 15 minims.
50 " " 1 fl. oz., 5 fl. drs, and 32 minims.
40 " " 1 fl. oz., 2 fl. drs. and 50 minims.
30 " " 1 fl oz. and 7 minims.

ENGLISH IMPERIAL MEASURES OF CAPACITY CONVERTED INTO METRIC.

TABLE XLII.

Imperial Gallons in Liters.

(1 Imperial Gallon = 4.54303432 Liters.)

1 Imperial Gallon =	4.543 Liters.	6 Imperial Gallons =	27.258 Liters.
2 Imperial Gallons "	9.086 "	7 " " "	31.801 "
3 " " "	13.629 "	8 " " "	36.344 "
4 " " "	18.172 "	9 " " "	40.887 "
5 " " "	22.715 "	10 " " "	45.430 "

TABLE XLIII.

Imperial Quarts in Liters.

(1 Imperial Quart= 1.13575858 Liters.)

1	Imperial Quart	= 1.136	Liters,	6	Imperial Quarts	= 6.814	Liters.
2	" Quarts	" 2.272	"	7	" "	" 7.950	"
3	" "	" 3.407	"	8	" "	" 9.086	"
4	" "	" 4.543	"	9	" "	" 10.222	"
5	" "	" 5.679	"	10	" "	" 11.358	"

TABLE XLIV.

Imperial Pints in Liters.

(1 Imperial Pint = 567.879290 Cubic-centimeters.)

1	Imperial Pint	= 0.5679	Liter.	6	Imperial Pints	= 3.4073	Liters.
2	Imperial Pints	" 1.1358	Liters.	7	" "	" 3.9752	"
3	" "	" 1.7036	"	8	" "	" 4.5430	"
4	" "	" 2.2715	"	9	" "	" 5.1109	"
5	" "	" 2.8394	"	10	" "	" 5.6788	"

TABLE XLV.

Imperial Fluidounces in Cubic-centimeters (or Fluigrams.)

(1 Imperial Fluidounce = 28.393964 Cubic-centimeters.)

1	Imp. Fluid oz.	= 28.39	Fluigrams	11	Imp. fl. ozs.	= 312.334	Fluigrams
2	" Fluid ozs.	" 56.79	"	12	" "	" 340.727	"
3	" "	" 85.18	"	13	" "	" 369.122	"
4	" "	" 113.58	"	14	" "	" 397.515	"
5	" "	" 141.97	"	15	" "	" 425.909	"
6	" "	" 170.364	"	16	" "	" 454.303	"
7	" "	" 198.758	"	17	" "	" 482.697	"
8	" "	" 227.152	"	18	" "	" 511.091	"
9	" "	" 255.546	"	19	" "	" 539.485	"
10	" "	" 283.940	"	20	" "	" 567.879	"

TABLE XLVI.

Imperial Fluidrachms in Cubic-centimeters (or Fluigrams).

(1 Imperial Fluidrachm = 3.54924556 Cubic-centimeters.)

1 Imp.	Fluidrachm	=	3.549	C.c.	11 Imp. Fluidrachms	=	39.042 C.c.
2 Imp.	Fluidrachms	"	7.098	"	12 " "	"	42.591 "
3 "	"	"	10.648	"	13 " "	"	46.140 "
4 "	"	"	14.197	"	14 " "	"	49.689 "
5 "	"	"	17.746	"	15 " "	"	53.239 "
6 "	"	"	21.295	"	16 " "	"	56.788 "
7 "	"	"	24.845	"	17 " "	"	60.337 "
8 "	"	"	28.394	"	18 " "	"	63.886 "
9 "	"	"	31.943	"	19 " "	"	67.436 "
10 "	"	"	35.492	"	20 " "	"	70.985 "

TABLE XLVII.

Imperial Minims in Cubic-centimeters (or Fluigrams).

(1 Imperial Minim = 0.05915409 Cubic-centimeters.)

1 Imp.	Minim	=	0.059	Fluigram.	20 Imp. Minims	=	1.183 C.c.
2 "	"	"	0.118	"	30 " "	"	1.775 "
3 "	"	"	0.177	"	40 " "	"	2.396 "
4 "	"	"	0.237	"	50 " "	"	2.958 "
5 "	"	"	0.296	"	60 " "	"	3.549 "
6 "	"	"	0.355	"	70 " "	"	4.140 "
7 "	"	"	0.414	"	80 " "	"	4.732 "
8 "	"	"	0.473	"	90 " "	"	5.324 "
9 "	"	"	0.532	"	100 " "	"	5.915 "
10 "	"	"	0.592	"	120 " "	"	7.098 "
11 "	"	"	0.651	"	150 " "	"	8.873 "
12 "	"	"	0.710	"	180 " "	"	10.647 "
13 "	"	"	0.769	"	200 " "	"	11.831 "
14 "	"	"	0.828	"	240 " "	"	14.197 "
15 "	"	"	0.887	"	300 " "	"	17.746 "
16 "	"	"	0.946	"	360 " "	"	21.295 "
17 "	"	"	1.006	"	400 " "	"	23.960 "
18 "	"	"	1.065	"	480 " "	"	28.394 "
19 "	"	"	1.124	"	1000 " "	"	59.154 "

METRIC MEASURES OF CAPACITY CONVERTED INTO ENGLISH IMPERIAL MEASURES.

TABLE XLVIII.

Liters in Imperial Gallons.

(1 Liter = 0.220117 Imperial Gallon.)

1	Liter	—	0.220	Imperial	Gallon.	6	Liters —	1.321	Imperial Gallon.
2	Liters	"	0.440	"	"	7	" "	1.541	" "
3	"	"	0.660	"	"	8	" "	1.761	" "
4	"	"	0.880	"	"	9	" "	1.981	" "
5	"	"	1.101	"	"	10	" "	2.201	" "

TABLE XLIX.

Liters in Imperial Quarts.

(1 Liter — 0.8804689 Imperial Quart.)

1	Liter		0.880	Imperial	Quart.	6	Liters —	5.283	Imperial Quarts.
2	Liters	"	1.761	"	"	7	" "	6.163	" "
3	"	"	2.641	"	"	8	" "	7.044	" "
4	"	"	3.522	"	"	9	" "	7.924	" "
5	"	"	4.402	"	"	10	" "	8.805	" "

TABLE L.

Liters in Imperial Pints.

(1 Liter — 1.76093766 Imperial Pint.)

1	Liter	—	1.761	Imperial	Pint.	6	Liters —	10.566	Imperial Pints.
2	Liters	"	3.522	"	"	7	" "	12.327	" "
3	"	"	5.283	"	"	8	" "	14.087	" "
4	"	"	7.044	"	"	9	" "	15.848	" "
5	"	"	8.805	"	"	10	" "	17.609	" "

TABLE LI.

Cubic-centimeters (or Fluigrams) in Imperial Fluidounces.

(1 Liter = 35.218753 Imperial Fluidounces.)

1	C.c.	—	0.035	Imp.	Fluidounce.	4	C.c. —	0.141	Imp. Fluidounce.
2	"	"	0.070	"	"	5	" "	0.176	" "
3	"	"	0.106	"	"	6	" "	0.211	" "

7	C.c.	—	0.247	Imp.	Fluidounce.	18	C.c.	—	0.633	Imp.	Fluidounce.
8	"	"	0.282	"	"	19	"	"	0.668	"	"
9	"	"	0.317	"	"	20	"	"	0.704	"	"
10	"	"	0.352	"	"	30	"	"	1.057	"	"
11	"	"	0.387	"	"	40	"	"	1.408	"	"
12	"	"	0.423	"	"	50	"	"	1.761	"	"
13	"	"	0.458	"	"	60	"	"	2.113	"	"
14	"	"	0.493	"	"	70	"	"	2.465	"	"
15	"	"	0.528	"	"	80	"	"	2.817	"	"
16	"	"	0.563	"	"	90	"	"	3.170	"	"
17	"	"	0.598	"	"	100	"	"	3.522	"	"

TABLE LII.

Cubic-centimeters (or Fluigrams) in Imperial Fluidrachms.

(1 Liter = 281.75002667 Imperial Fluidrachms.)

1	C.c.	—	0.282	Imp.	Fluidrachm.	24	C.c.	—	6.762	Imp.	Fluidrachm.
2	"	"	0.564	"	"	25	"	"	7.044	"	"
3	"	"	0.845	"	"	26	"	"	7.325	"	"
4	"	"	1.127	"	"	27	"	"	7.607	"	"
5	"	"	1.409	"	"	28	"	"	7.889	"	"
6	"	"	1.691	"	"	29	"	"	8.171	"	"
7	"	"	1.972	"	"	30	"	"	8.453	"	"
8	"	"	2.254	"	"	31	"	"	8.735	"	"
9	"	"	2.536	"	"	32	"	"	9.016	"	"
10	"	"	2.818	"	"	33	"	"	9.298	"	"
11	"	"	3.099	"	"	34	"	"	9.580	"	"
12	"	"	3.381	"	"	35	"	"	9.861	"	"
13	"	"	3.663	"	"	36	"	"	10.142	"	"
14	"	"	3.944	"	"	37	"	"	10.425	"	"
15	"	"	4.226	"	"	38	"	"	10.706	"	"
16	"	"	4.508	"	"	39	"	"	10.988	"	"
17	"	"	4.789	"	"	40	"	"	11.270	"	"
18	"	"	5.072	"	"	50	"	"	14.087	"	"
19	"	"	5.353	"	"	60	"	"	16.905	"	"
20	"	"	5.635	"	"	70	"	"	19.723	"	"
21	"	"	5.917	"	"	80	"	"	22.540	"	"
22	"	"	6.199	"	"	90	"	"	25.358	"	"
23	"	"	6.480	"	"	100	"	"	28.175	"	"

TABLE LIII.

Cubic-centimeters (or Fluigrams) in Imperial Minims.

(1 Cubic-centimeter = 16.90500160 Imperial Minims.)

1	C.c.	—	16.905	Imp.	Minims.	16	C.c.	—	270.480	Imp. Minims.
2	"	"	33.810	"	"	17	"	"	287.385	" "
3	"	"	50.715	"	"	18	"	"	304.290	" "
4	"	"	67.620	"	"	19	"	"	321.195	" "
5	"	"	84.525	"	"	20	"	"	338.100	" "
6	"	"	101.430	"	"	21	"	"	355.005	" "
7	"	"	118.335	"	"	22	"	"	371.910	" "
8	"	"	135.240	"	"	23	"	"	388.815	" "
9	"	"	152.145	"	"	24	"	"	405.720	" "
10	"	"	169.050	"	"	25	"	"	422.625	" "
11	"	"	185.955	"	"	26	"	"	439.530	" "
12	"	"	202.865	"	"	27	"	"	456.435	" "
13	"	"	219.770	"	"	28	"	"	473.340	" "
14	"	"	236.670	"	"	29	"	"	490.245	" "
15	"	"	253.575	"	"	30	"	"	507.150	" "

WINE AND U. S. APOTHECARIES' MEASURE CONVERTED INTO IMPERIAL MEASURE.

TABLE LIV.

Wine Gallons in Imperial Gallons.

(1 Wine Gallon = 0.83321182 Imperial Gallon.)

1	Wine	Gallon	—	0.833	Imp. Gall.	6	Wine	Gallons	—	4.999 Imp. Gall.
2	"	"	"	1.666	"	7	"	"	"	5.832 "
3	"	"	"	2.500	"	8	"	"	"	6.666 "
4	"	"	"	3.333	"	9	"	"	"	7.499 "
5	"	"	"	4.166	"	10	"	"	"	8.332 "

The same relations obtain between the quarts and pints wine measure, and the quarts and pints Imperial measure, 1 wine quart being equal to 0.833212 Imperial quart, and 1 wine pint equal to 0.833212 Imperial pint.

TABLE LV.

U. S. Fluidounces in Imperial Fluidounces.

(1 U. S. Fluidounce — 1.041139775 Imperial Fluidounces.

1	U. S. Fl.oz.	—	1.041	Imp. Fl.oz.	4	U. S. Fl.oz.	—	4.164	Imp. Fl.oz.
2	" "	"	2.082	" "	5	" "	"	5.206	" "
3	" "	"	3.123	" "	6	" "	"	6.247	" "

7	U. S.	Fl.	oz.	—	7.288	Imp.	Fl.	oz.	18	U. S.	Fl.	oz.	—	18.740	Imp. Fl. oz.
8	"	"	"		8.329	"	"		19	"	"	"		19.782	" "
9	"	"	"		9.370	"	"		20	"	"	"		20.822	" "
10	"	"	"		10.411	"	"		30	"	"	"		31.123	" "
11	"	"	"		11.453	"	"		40	"	"	"		41.645	" "
12	"	"	"		12.494	"	"		50	"	"	"		52.056	" "
13	"	"	"		13.535	"	"		60	"	"	"		62.468	" "
14	"	"	"		14.576	"	"		70	"	"	"		72.880	" "
15	"	"	"		15.617	"	"		80	"	"	"		83.291	" "
16	"	"	"		16.658	"	"		90	"	"	"		93.703	" "
17	"	"	"		17.699	"	"		100	"	"	"		104.114	" "

The same relations obtain between the fluidrachms and minims of U. S. apothecaries' fluid measure, and the fluidrachms and minims Imperial measure, 1 U. S. fluidrachm being equal to 1.041140 Imperial fluidrachm, and 1 U. S. minim equal to 1.041140 Imperial minim.

IMPERIAL MEASURE CONVERTED INTO WINE AND U S. APOTHECARIES' MEASURE.

TABLE LVI.

Imperial Pints in Wine Pints.

(1 Imperial Pint = 1.200175 Pints.)

1	Imp.	Pint	—	1.20	Wine	Pints.			6	Imp.	Pints	—	7.20	Wine	Pints.
2	"	Pints	"	2.40	"	"			7	"	"	"	8.40	"	"
3	"	"	"	3.60	"	"			8	"	"	"	9.60	"	"
4	"	"	"	4.80	"	"			9	"	"	"	10.80	"	"
5	"	"	"	6.00	"	"			10	"	"	"	12.00	"	"

The same relations obtain between the quart and the gallon Imperial measure, and the wine quart and wine gallon, 1 Imperial quart being equal to 1.200175 Wine quart and 1 Imperial gallon equal to 1.200175 wine gallon.

TABLE LVII.

Imperial Fluidounces in U. S. Fluidounces.

(1 Imperial Fluidounce = 0.960140 U. S. Fluidounce.

1	Imp.	Fluid	oz.	—	0.960	Fl.	oz.		6	Imp.	Fluid	oz.	—	5.761	Fl. oz.
2	"	"	"		1.920	"			7	"	"	"		6.721	"
3	"	"	"		2.880	"			8	"	"	"		7.681	"
4	"	"	"		3.840	"			9	"	"	"		8.641	"
5	"	"	"		4.801	"			10	"	"	"		9.601	"

11	Imp.	Fluid oz.	—	10.562	Fl. oz.	20	Imp.	Fluid oz.	—	19.203 Fl. oz.
12	"	"	"	11.522	"	30	"	"	"	28.804 "
13	"	"	"	12.482	"	40	"	"	"	38.406 "
14	"	"	"	13.442	"	50	"	"	"	48.007 "
15	"	"	"	14.402	"	60	"	"	"	57.608 "
16	"	"	"	15.362	"	70	"	"	"	67.210 "
17	"	"	"	16 322	"	80	"	"	"	76.811 "
18	"	"	"	17.282	"	90	"	"	"	86.413 "
19	"	"	"	18.243	"	100	"	"	"	96.014 "

The same relations obtain between the fluidrachms and minims Imperial measure and the U. S. fluidrachms and minims, 1 Imperial fluidrachm being equal to 0.960140 U. S. fluidrachm, and 1 Imperial minim equal to 0.960140 U. S. minim.

AVOIRDUPOIS WEIGHT CONVERTED INTO METRIC.

TABLE LVIII.

Avoidupois Pounds in Grams.

(1 Avoirdupois Pound — 453.59265 Grams.)

1	Avoird.	Pound —		453.59	Grams.	6	Avoird.	Pounds—		2,721.55 Gms.
2	"	Pounds "		907.18	"	7	"	"	"	3,175.14 "
3	"	"	"	1,360.78	"	8	"	"	"	3,628.74 "
4	"	"	"	1,814.37	"	9	"	"	"	4,082.33 "
5	"	"	"	2,267.96	"	10	"	"	"	4,535.92 "

TABLE LIX.

Avoirdupois Ounces in Grams.

(1 Avoirdupois Ounce — 28.349541 Grams.)

⅛	Avoird.	Ounce—		1.772	Grams.	6	Avoird.	ounce —		170.097 Grams.
¼	"	"	"	3.544	"	7	"	"	"	198.447 "
½	"	"	"	7.088	"	8	"	"	"	226.796 "
¾	"	"	"	14.175	"	9	"	"	"	255.146 "
1	"	"	"	28.350	"	10	"	"	"	283.496 "
2	"	"	"	56.699	"	11	"	"	"	311.846 "
3	"	"	"	85.049	"	12	"	"	"	340.195 "
4	"	"	"	113.398	"	13	"	"	"	368.544 "
5	"	"	"	141.748	"	14	"	"	"	396.894 "

15	Avoird.	ozs.	=	425.243	Grams.	29	Avoird.	ozs. =	822.137	Grams.
16	"	"	"	453.592	"	30	"	" "	850.486	"
17	"	"	"	481.942	"	31	"	" "	878.836	"
18	"	"	"	510.292	"	32	"	" "	907.185	"
19	"	"	"	538.641	"	33	"	" "	935.535	"
20	"	"	"	566.991	"	34	"	" "	963.884	"
21	"	"	"	595.340	"	35	"	" "	992.234	"
22	"	"	"	623.690	"	40	"	" "	1,133.981	"
23	"	"	"	652.039	"	50	"	" "	1,417.477	"
24	"	"	"	680.390	"	60	"	" "	1,700.972	"
25	"	"	"	708.738	"	70	"	" "	1,984.468	"
26	"	"	"	737.090	"	80	"	"	2,267.963	"
27	"	"	"	765.438	"	90	"	" "	2,551.459	"
28	"	"	"	793.787	"	100	"	" "	2,834.954	"

METRIC WEIGHT CONVERTED INTO AVOIRDUPOIS.

TABLE LX.

Kilograms in Avoirdupois Pounds.

(1 Kilogram = 2.20462125 Avoirdupois Pounds.)

1	Kilogram	=	2.205	Av.	Pounds.	6	Kilograms	=	13.228	Av. Pounds.
2	Kilograms	"	4.409		"	7	"	"	15.432	"
3	"	"	6.614		"	8	"	"	17.637	"
4	"	"	8.818		"	9	"	"	19.842	"
5	"	"	11.023		"	10	"	"	22.046	"

TABLE LXI.

Kilograms in Avoirdupois Pounds and Ounces.

(1 Kilogram = 2 lbs., 3 ounces and 720 grains.)

		lbs.	ozs.	grs.		lbs.	ozs.	grs.
1	Kilogram =	2	3	120	6 Kilograms =	13	3	283
2	Kilograms "	4	6	240	7 " "	15	6	403
3	" "	6	9	360	8 " "	17	10	86
4	" "	8	13	43	9 " "	19	13	206
5	" "	11	—	163	10 " "	22	—	326

Grams	=	1	oz.	and	10	grains.
"	"	1	"		25	"
"	"	1	"		41	"
"	"	1	"		57	"
"	"	1	"		72	"
"	"	1	"		87	"
"	"	1	"		103	"
"	"	1	"		118	"
"	"	1	"		133	"
"	"	1	"		149	"
"	"	1	"		164	"
"	"	1	"		180	"
"	"	1	"		195	"
"	"	1	"		211	"
"	"	1	"		226	"
"	"	1	"		242	"
"	"	1	"		257	"
"	"	1	"		272	"
"	"	1	"		288	"
"	"	1	"		303	"
"	"	1	"		318	"
"	"	1	"		334	"
"	"	1	"		349	"
"	"	1	"		364	"
"	"	1	"		379	"
"	"	1	"		395	"
"	"	1	"		411	"
"	"	1	"		426	"
"	"	2	"		5	"
"	"	2	"		20	"
"	"	2	"		35	"
"	"	2	"		51	"
"	"	2	"		66	"
"	"	2	"		82	"
"	"	2	"		97	"
"	"	2	"		112	"
"	"	2	"		128	"
"	"	2	"		143	"
"	"	2	"		158	"
"	"	2	"		174	"
"	"	2	"		189	"

70	Grams	=	2	ozs.	and	206	grains.
71	"	"	2	"		221	"
72	"	"	2	"		236	"
73	"	"	2	"		252	"
74	"	"	2	"		267	"
75	"	"	2	"		282	"
76	"	"	2	"		298	"
77	"	"	2	"		313	"
78	"	"	2	"		329	"
79	"	"	2	"		344	"
80	"	"	2	"		360	"
81	"	"	2	"		375	"
82	"	"	2	"		390	"
83	"	"	2	"		406	"
84	"	"	2	"		421	"
85	"	"	2	"		437	"
86	"	"	3	"		15	"
87	"	"	3	"		30	"
88	"	"	3	"		46	"
89	"	"	3	"		61	"
90	"	"	3	"		77	"
91	"	"	3	"		92	"
92	"	"	3	"		108	"
93	"	"	3	"		123	"
94	"	"	3	"		138	"
95	"	"	3	"		154	"
96	"	"	3	"		169	"
97	"	"	3	"		184	"
98	"	"	3	"		200	"
99	"	"	3	"		215	"
100	"	"	3	"		231	"
150	"	"	5	"		127	"
200	"	"	7	"		24	"
250	"	"	8	"		358	"
300	"	"	10	"		255	"
350	"	"	12	"		151	"
400	"	"	14	"		48	"
450	"	"	15	"		381	"
500	"	"	17	"		279	"
1,000	"	"	35	"		120	"

AVOIRDUPOIS WEIGHT CONVERTED INTO TROY AND U. S. APOTHECARIES' WEIGHT.

TABLE LXIV.

Avoirdupois Pounds in Troy Pounds.

(1 Avoirdupois Pound 1.215278 Troy Pound.)

1	Av. Pound	=	1.215	Troy Pound.	6	Avoird. Pounds =	7.291 Troy lbs.
2	" Pounds	"	2.430	"	7	" "	8.506 "
3	" "	"	3.636	"	8	" "	9.722 "
4	" "	"	4.861	"	9	" "	10.937 "
5	" "	"	6.076	"	10	" "	12.153 "

TABLE LXV.

Avoirdupois Pouuds in Troy (or U. S. Apothecaries') Ounces.

(1 Avoirdupois Pound = 14.583333 Troy Ounces.)

1	Avoird. Pound	=	14.58	Troy oz.	6	Avoird. Pounds =	87.50 Troy oz
2	Avoird. Pounds	"	29.17	"	7	" "	102.08 "
3	" "	"	43.75	"	8	" "	116.67 "
4	" "	"	58.33	"	9	" "	131.25 "
5	" "	"	72.92	"	10	" "	145.83 "

TABLE LXVI.

Avoirdupois Ounces in Troy (or U. S. Apothecaries') Ounces.

(1 Avoirdupois Ounce = 0.911458 Troy Ounce.)

1	Avoird. Ounce	=	0.911	Troy oz.	12	Av. Ouuces =	10.937 Troy ozs.
2	Av. Ounces	"	1.823	"	13	" "	11.849 "
3	" "	"	2.734	"	14	" "	12.760 "
4	" "	"	3.646	"	15	" "	13.672 "
5	" "	"	4.557	"	16	" "	14.583 "
6	" "	"	5.469	"	17	" "	15.495 "
7	" "	"	6.380	"	18	" "	16.406 "
	" "	"	7.292	"	19	" "	17.318 "
	" "	"	8.203	"	20	" "	18.229 "
	" "	"	9.115	"	21	" "	19.141 "
	" "	"	10.026	"	22	" "	20.052 "

23	Av. Ounces	=	20.964	Troy ozs.	33	Av. Ounces	= 30.078	Troy ozs.
24	"	"	21.875	"	34	"	" 30.990	"
25	"	"	22.786	"	35	"	" 31.901	"
26	"	"	23.698	"	36	"	" 32.812	"
27	"	"	24.609	"	37	"	" 33.724	"
28	"	"	25.520	"	38	"	" 34.635	"
29	"	"	26.432	"	39	"	" 35.547	"
30	"	"	27.344	"	40	"	" 36.458	"
31	"	"	28.255	"	50	"	" 45.573	"
32	"	"	29.167	"	100	"	" 91.146	"

TROY AND U. S. APOTHECARIES' WEIGHT CONVERTED INTO AVOIRDUPOIS.

TABLE LXVII.

Troy Pounds in Avoirdupois Pounds.

(1 Troy Pound = 0.822857 Avoirdupois Pound.)

1	Troy Pound	=	0.823	Avoir. lb.	6	Troy Qounds	= 4.936	Avoir. lbs.
2	Troy Pounds	"	1 646	"	7	"	" 5.760	"
3	"	"	2.469	"	8	"	" 6.583	"
4	"	"	3.291	"	9	"	" 7.406	"
5	"	"	4.114	"	10	"	" 8.229	"

TABLE LXVIII.

Troy Ounces (or U. S. Apothecaries') Ounces in Avoirdupois Ounces.

(1 Troy Ounce = 1.097143 Avoirdupois Ounces.)

1	Troy Ounce	=	1.097	Av. Oz.	11	Troy Ounces	= 12.069	Av. oz.
2	Troy Ounces	"	2.194	"	12	"	" 13.166	"
3	"	"	3.291	"	13	"	" 14 263	"
4	"	"	4.389	"	14	"	" 15.360	"
5	"	"	5.486	"	15	"	" 16.457	"
6	"	"	6.583	"	16	"	" 17.554	"
7	"	"	7.680	"	17	"	" 18.651	"
8	"	"	8.777	"	18	"	" 19.749	"
9	"	"	9.874	"	19	"	" 20.846	"
10	"	"	10.971	"	20	"	" 21.943	"

21	Troy Ounces	=	23.040	Av. ozs.	32	Troy Ounces =	35.009 Av. ozs.
22	"	"	24.137	"	33	" "	36.206 "
23	"	"	25.234	"	34	" "	37.303 "
24	"	"	26.331	"	35	" "	38.400 "
25	"	"	27.429	"	40	" "	43.886 "
26	"	"	28.526	"	50	" "	54.857 "
27	"	"	29.623	"	60	" "	65.829 "
28	"	"	30.720	"	70	" "	76.800 "
29	"	"	31.817	"	80	" "	87.771 "
30	"	"	32.914	"	90	" "	98.743 "
31	"	"	34.011	"	100	" "	109.714 "

TABLE LXIXI.

Troy (or U. S. Apothecaries') Ounces in Grams.

(1 Troy Ounce = 31.103496 Grams.)

⅛	Troy Ounce	=	3.888	Grams.	22	Troy Ounces =	684.277 Grams.
¼	"	"	7.776	"	23	" "	715.380 "
½	"	"	15.552	"	24	" "	746.499 "
¾	"	"	23.328	"	25	" "	777.587 "
1	"	"	31.103	"	26	" "	808.691 "
1⅛	"	"	40.655	"	27	" "	839.794 "
2	"	"	62.207	"	28	" "	870.900 "
3	"	"	93.310	"	29	" "	902.001 "
4	"	"	124.415	"	30	" "	933.105 "
5	"	"	155.517	"	31	" "	964.219 "
6	"	"	186.621	"	32	" "	995.322 "
7	"	"	217.724	"	33	" "	1026.425 "
8	"	"	248.830	"	34	" "	1057.529 "
9	"	"	279.932	"	35	" "	1089.633 "
10	"	"	311.035	"	36	" "	1119.736 "
11	"	"	342.138	"	37	" "	1150.840 "
12	"	"	373.250	"	38	" "	1181.943 "
13	"	"	404.345	"	39	" "	1213.046 "
14	"	"	435.449	"	40	" "	1244.150 "
15	"	"	466.552	"	50	" "	1555.175 "
16	"	"	497.656	"	60	" "	1866.209 "
17	"	"	528.759	"	70	" "	2177.244 "
18	"	"	559.863	"	80	" "	2488.300 "
19	"	"	590.966	"	90	" "	2799.325 "
20	"	"	622.070	"	100	" "	3110.350 "
21	"	"	653.173	"			

TABLE LXX.

U. S. Apothecaries' Drachms in Grams.

(1 U. S. Apothecaries' Drachm = 3.887937 Grams.)

Drachm	=	3.888	Grams.	24	Drachms	=	93.310 Grams.
"	"	7.776	"	25	"	"	97.198 "
"	"	11.664	"	26	"	"	101.086 "
"	"	15 552	"	27	"	"	104.974 "
"	"	19.440	"	28	"	"	108.862 "
"	"	23.328	"	29	"	"	112.750 "
"	"	27.216	"	30	"	"	116.638 "
"	"	31.103	"	31	"	"	120.526 "
"	"	34.991	"	32	"	"	124.414 "
"	"	38.879	"	33	"	"	128.302 "
"	"	42.767	"	34	"	"	132.190 "
"	"	46.655	"	35	"	"	136.078 "
"	"	50.543	"	36	"	"	139.966 "
"	"	54.431	"	37	"	"	143.854 "
"	"	58.319	"	38	"	"	147.742 "
"	"	62.207	"	39	"	"	151.630 "
"	"	66.095	"	40	"	"	155.517 "
"	"	69.983	"	50	"	"	194.397 "
"	"	73.871	"	60	"	"	233.276 "
"	"	77.759	"	70	"	"	272.156 "
"	"	81.647	"	80	"	"	311.035 "
"	"	85.535	"	90	"	"	349.914 "
"	"	89.423	"	100	"	"	388.794 "

TABLE LXXI.

Grains in Grams.

(1 Grain = 0.06479895.)

Grain	=	0.101	Milligram.	$\frac{1}{180}$	Grain	=	0.259 Milligram.
"	"	0.108	"	$\frac{1}{100}$	"	"	0.324 "
"	"	0.130	"	$\frac{1}{80}$	"	"	0.405 "
"	"	0.135	"	$\frac{1}{120}$	"	"	0.540 "
"	"	0.162	"	$\frac{1}{100}$	"	"	0.648 "
"	"	0.180	"	$\frac{1}{50}$	"	"	0.720 "
"	"	0.202	"	$\frac{1}{80}$	"	"	0.810 "
"	"	0.216	"	$\frac{1}{70}$	"	"	0.926 "

1/64	Grain	= 1.01	Milligrams.
1/60	"	" 1.08	"
1/50	"	" 1.30	"
1/48	"	" 1.35	"
1/40	"	" 1.62	"
1/36	"	" 1.80	"
1/32	"	" 2.02	"
1/30	"	" 2.16	"
1/25	"	" 2.59	"
1/24	"	" 2.70	"
1/20	"	" 3.24	"
1/18	"	" 3.60	"
1/16	"	" 4.05	"
1/15	"	" 4.32	"
1/12	"	" 5.40	"
1/10	"	" 6.48	"
1/9	"	" 7.20	"
1/8	"	" 8.10	"
1/7	"	" 9.26	"
1/6	"	" 10.80	"
1/5	"	" 12.96	"
1/4	"	" 16.20	"
1/3	"	" 21.60	"
2/5	"	" 24.30	"
7/18	"	" 28.35	"
1/2	"	" 32.40	"
9/18	"	" 36.45	"
5/8	"	" 40.50	"
11/18	"	" 44.55	"
3/4	"	" 48.60	"
13/18	"	" 52.65	"
7/8	"	" 56 70	"
15/16	"	" 60 75	"
1	"	" 64 80	"
1 1/2	"	" 97.20	"
2	"	" 12.96	Centigrams.
3	"	" 19.44	"
4	"	" 25.92	"
5	"	" 32.40	"
6	"	" 38.88	"
7	"	" 45.36	"
8	"	" 51.84	"

9	Grains	= 58.32	Centigrams.
10	"	" 64.80	"
11	"	" 71.28	"
12	"	" 77.76	"
13	"	" 84.24	"
14	"	" 90.72	"
15	"	" 97.20	"
16	"	" 1.037	Grams.
17	"	" 1.102	"
18	"	" 1.166	"
19	"	" 1.231	"
20	"	" 1.296	"
21	"	" 1.361	"
22	"	" 1.426	"
23	"	" 1.490	"
24	"	" 1.555	"
25	"	" 1.620	"
26	"	" 1.685	"
27	"	" 1.750	"
28	"	" 1.814	"
29	"	" 1.879	"
30	"	" 1.944	"
31	"	" 2.009	"
32	"	" 2.074	"
33	"	" 2.138	"
34	"	" 2.203	"
35	"	" 2.268	"
36	"	" 2.333	"
37	"	" 2.398	"
38	"	" 2.462	"
39	"	" 2.527	"
40	"	" 2.592	"
41	"	" 2.657	"
42	"	" 2.722	"
43	"	" 2.786	"
44	"	" 2.851	"
45	"	" 2.916	"
46	"	" 2.981	"
47	"	" 3.046	"
48	"	" 3.110	"
49	"	" 3.175	"
50	"	" 3.240	"

Grains	= 3.305	Grams.	78 Grains	= 5.054	Grams.
"	" 3.370	"	79 "	" 5.119	"
"	" 3.434	"	80 "	" 5.184	"
"	" 3.499	"	81 "	" 5.249	"
"	" 3.564	"	82 "	" 5.314	"
"	" 3.629	"	83 "	" 5.378	"
"	" 3.694	"	84 "	" 5.443	"
"	" 3.758	"	85 "	" 5.508	"
"	" 3.823	"	86 "	" 5.573	"
"	" 3.888	"	87 "	" 5 638	"
"	" 3.953	"	88 "	" 5,702	"
"	" 4.018	"	89 "	" 5.767	"
"	" 4.082	"	90 "	" 5.832	"
"	" 4.147	"	91 "	" 5.897	"
"	" 4.212	"	92 "	" 5.962	"
"	" 4 277	"	93 "	" 6.026	"
"	" 4.342	"	94 "	" 6.091	"
"	" 4.406	"	95 "	" 6.156	"
"	" 4.471	"	96 "	" 6.221	"
"	" 4.536	"	97 "	" 6.286	"
"	" 4.601	"	98 "	" 6.350	"
"	" 4.666	"	99 "	" 6.415	"
"	" 4.730	"	100 "	" 9.480	"
"	" 4.795	"	128 "	" 8.294	"
"	" 4.860	"	256 "	"16.588	"
"	" 4.925	"	512 "	"33.177	"
"	" 4.990	"	1.000 "	"64.799	"

METRIC WEIGHT CONVERTED INTO TROY AND U. S. APOTHECARIES' WEIGHT.

TABLE LXXII.

Kilograms in Troy (or U. S. Apothecaries') Ounces.

(1 Kilogram = 32.150727 Troy Ounces.)

Kilogram	= 32.15	Troy Ounces.	6 Kilograms	= 192.90	Troy ozs.
Kilograms	" 64.30	"	7 "	" 225.05	"
"	" 96.45	"	8 "	" 257.20	"
"	" 128.60	"	9 "	" 289.35	"
"	" 160.75	"	10 "	" 321.51	"

TABLE LXXIII.

Grams in Troy (or U. S. Apothecaries') Ounces.

(1 Kilogram = 32.150727 Troy Ounces.)

1	Gram	=	0.032	Troy Ounce.			
2	Grams	"	0.064	"	39	Grams =	1.254 Troy Ounces.
3	"	"	0.096	"	40	" "	1.286 "
4	"	"	0.129	"	41	" "	1.318 "
5	"	"	0.161	"	42	" "	1.350 "
6	"	"	0.193	"	43	" "	1.382 "
7	"	"	0.225	"	44	" "	1.415 "
8	"	"	0.257	"	45	" "	1.447 "
9	"	"	0.289	"	46	" "	1.479 "
10	"	"	0.322	"	47	" "	1.511 "
11	"	"	0.354	"	48	" "	1.543 "
12	"	"	0.386	"	49	" "	1.575 "
13	"	"	0.418	"	50	" "	1.608 "
14	"	"	0.450	"	51	" "	1.640 "
15	"	"	0.482	"	52	" "	1.672 "
16	"	"	0.514	"	53	" "	1.704 "
17	"	"	0.547	"	54	" "	1.736 "
18	"	"	0.579	"	55	" "	1.768 "
19	"	"	0.611	"	56	" "	1.800 "
20	"	"	0.643	"	57	" "	1.833 "
21	"	"	0.675	"	58	" "	1.865 "
22	"	"	0.707	"	59	" "	1.897 "
23	"	"	0.739	"	60	" "	1.929 "
24	"	"	0.772	"	61	" "	1.961 "
25	"	"	0.804	"	62	" "	1.993 "
26	"	"	0.836	"	63	" "	2.025 "
27	"	"	0.868	"	64	" "	2 058 "
28	"	"	0.900	"	65	" "	2.090 "
29	"	"	0.932	"	66	" "	2.122 "
30	"	"	0.965	"	67	" "	2.154 "
31	"	"	0.997	"	68	" "	2.186 "
32	"	"	1.029	"	69	" "	2.218 "
33	"	"	1.061	"	70	" "	2.251 "
34	"	"	1.093	"	71	" "	2.283 "
35	"	"	1.125	"	72	" "	2.315 "
36	"	"	1.157	"	73	" "	2.347 "
37	"	"	1.190	"	74	" "	2.379 "
38	"	"	1.222	"	75	" "	2.411 "
					76	" "	2.443 "

77	Grams	=	2.476	Troy Ounces.	89	Grams =	2.861 Troy Ounces.
78	"	"	2.508	"	90	" "	2.894 "
79	"	"	2.540	"	91	" "	2.926 "
80	"	"	2.572	"	92	" "	2.958 "
81	"	"	2.604	"	93	" "	2.990 "
82	"	"	2.636	"	94	" "	3.022 "
83	"	"	2.668	"	95	" "	3.054 "
84	"	"	2.701	"	96	" "	3.086 "
85	"	"	2.733	"	97	" "	3.119 "
86	"	"	2.765	"	98	" "	3.151 "
87	"	"	2.797	"	99	" "	3.183 "
88	"	"	2.829	"	100	" "	3.215 "

[See also preceding table.]

TABLE LXXIV.

Grams in U. S. Apothecaries' Drachms.

(1 Kilogram = 257.205812 Drachms.)

1	Gram	=	0.257	Drachm.	12	Grams =	3.086 Drachms.
2	Grams	"	0.514	"	13	" "	3.343 "
3	"	"	0.772	"	14	" "	3.601 "
4	"	"	1.029	"	15	" "	3.858 "
5	"	"	1.286	"	16	" "	4.115 "
6	"	"	1.543	"	17	" "	4.372 "
7	"	"	1.800	"	18	" "	4.630 "
8	"	"	2.058	"	19	" "	4.887 "
9	"	"	2.315	"	20	" "	5.144 "
10	"	"	2.572	"	30	" "	7.716 "
11	"	"	2.829	"			

TABLE LXXV.

Grams in Troy or (U. S. Apothecaries') Grains.

(1 Gram = 15.43234874 grains.)

1	Gram	=	15.432	grains.	7	Grams = 08.026	grains.
2	Grams	"	30.864	"	8	" " 123.459	"
3	"	"	46.297	"	9	" " 138.891	"
4	"	"	61.729	"	10	" " 154.323	"
5	"	"	77.162	"	11	" " 169.756	"
6	"	"	92.594	"	12	" " 185.188	"

13	Grams	=	00.621	grains.		
14	"	"	216.053	"		
15	"	"	231.485	"		
16	"	"	246.918	"		
17	"	"	262.350	"		
18	"	"	277.782	"		
19	"	"	293.215	"		
20	"	"	308.647	"		
21	"	"	324.079	"		
22	"	"	339.512	"		
23	"	"	354.944	"		
24	"	"	370.376	"		
25	"	"	385.809	"		
26	"	"	401.241	"		
27	"	"	416.673	"		
28	"	"	432.106	"		
29	"	"	447.538	"		
30	"	"	462.970	"		
31	"	"	478 403	"		
32	"	"	1 oz.	and	14	grains.
33	"	"	1	"	29	"
34	"	"	1	"	45	"
35	"	"	1	"	60	"
36	"	"	1	"	76	"
37	"	"	1	"	90	"
38	"	"	1	"	106	"
39	"	"	1	"	122	"
40	"	"	1	"	137	"
41	"	"	1	"	153	"
42	"	"	1	"	168	"
43	"	"	1	"	183	"
44	"	"	1	"	199	"
45	"	"	1	"	214	"
46	"	"	1	"	230	"
47	"	"	1	"	245	"
48	"	"	1	"	261	"
49	"	"	1	"	276	"
50	"	"	1	"	292	"
51	"	"	1	"	307	"
52	"	"	1	"	323	"
53	"	"	1	"	338	"
54	"	"	1	"	353	"
55	Grams	=	1 oz.	and	369	grs.
56	"	"	1	"	384	"
57	"	"	1	"	400	"
58	"	"	1	"	415	"
59	"	"	1	"	431	"
60	"	"	1	"	446	"
61	"	"	2	"	461	"
62	"	"	2	"	477	"
63	"	"	2	"	12	"
64	"	"	2	"	28	"
65	"	"	2	"	43	"
66	"	"	2	"	59	"
67	"	"	2	"	74	"
68	"	"	2	"	89	"
69	"	"	2	"	104	"
70	"	"	2	"	120	"
71	"	"	2	"	136	"
72	"	"	2	"	151	"
73	"	"	2	"	167	"
74	"	"	2	"	182	"
75	"	"	2	"	197	"
76	"	"	2	"	213	"
77	"	"	2	"	228	"
78	"	"	2	"	244	"
79	"	"	2	"	259	"
80	"	"	2	"	275	"
81	"	"	2	"	290	"
82	"	"	2	"	305	"
83	"	"	2	"	321	"
84	"	"	2	"	336	"
85	"	"	2	"	352	"
86	"	"	2	"	367	"
87	"	"	2	"	383	"
88	"	"	2	"	398	"
89	"	"	2	"	414	"
90	"	"	2	"	429	"
91	"	"	2	"	444	"
92	"	"	2	"	460	"
93	"	"	2	"	475	"
94	"	"	3	"	11	"
95	"	"	3	"	26	"
96	"	"	3	"	42	"

97	Grams	=	3	ozs.	and	57	grs.	600	Gm.	=	19	ozs. and 139 grs.
98	"	"	3	"		72	"	650	"	"	20	" 431 "
99	"	"	3	"		88	"	700	"	"	22	" 243 "
100	"	"	3	"		103	"	750	"	"	24	" 54 "
125	"	"	4	"		9	"	800	"	"	35	" 346 "
150	"	"	4	"		395	"	850	"	"	27	" 157 "
200	"	"	6	"		206	"	900	"	"	28	" 449 "
250	"	"	8	"		18	"	950	"	"	30	" 260 "
300	"	"	9	"		310	"	1,000	"	"	32	" 72 "
350	"	"	11	"		121	"	2,000	"	"	64	" 145 "
400	"	"	12	"		413	"	3,000	"	"	96	" 217 "
450	"	"	14	"		225	"	4,000	"	"	128	" 289 "
500	"	"	16	"		36	"	5,000	"	"	160	" 262 "
550	"	"	17	"		328	"	10,000	"	"	821	" 23 "

TABLE LXXVI.

Milligrams, Centigrams and Grams in Grains.

(1 Gram = 15.43234874 Grains.

1	Milligram	—	0.015	grain.		1.0	Centigram	—	0.154	grain.		
1.5	"	"	0.023	"		1.2	"	"	0.185	"		
2.0	"	"	0.031	"		1.4	"	"	0.216	"		
2.5	"	"	0.039	"		1.6	"	"	0.247	"		
3.0	"	"	0.046	"		1.8	"	"	0.278	"		
3.5	"	"	0.054	"		2	"	"	0.309	"		
4.0	"	"	0.062	"		3	"	"	0.463	"		
4.5	"	"	0.069	"		4	"	"	0.617	"		
5.0	"	"	0.077	"		5	"	"	0.772	"		
5.5	"	"	0.085	"		6	"	"	0.926	"		
6.0	"	"	0.093	"		7	"	"	1.080	"		
6.5	"	"	0.100	"		8	"	"	1.235	"		
7.0	"	"	0.108	"		9	"	"	1.389	"		
7.5	"	"	0.116	"		10	"	"	1.543	"		
8.0	"	"	0.123	"		11	"	"	1.698	"		
8.5	"	"	0.131	"		12	"	"	1.852	"		
9.0	"	"	0.139	"		13	"	"	2.006	"		
9.5	"	"	0.147	"		14	"	"	2.161	"		

15	Centigrams	—	2.315 grains.	57	Centigrams	—	8.796 grains.
16	"	"	2.469 "	58	"	"	8.951 "
17	"	"	2.623 "	59	"	"	9.105 "
18	"	"	2.778 "	60	"	"	9.259 "
19	"	"	2.932 "	61	"	"	9.414 "
20	"	"	3.086 "	62	"	"	9.568 "
21	"	"	3.241 "	63	"	"	9.722 "
22	"	"	3.395 "	64	"	"	9.877 "
23	"	"	3.549 "	65	"	"	10.031 "
24	"	"	3.704 "	66	"	"	10.185 "
25	"	"	3.858 "	67	"	"	10.340 "
26	"	"	4.012 "	68	"	"	10.494 "
27	"	"	4.167 "	69	"	"	10.640 "
28	"	"	4.321 "	70	"	"	10.803 "
29	"	"	4.475 "	71	"	"	10.957 "
30	"	"	4.630 "	72	"	"	11.111 "
31	"	"	4.784 "	73	"	"	11.266 "
32	"	"	4.938 "	74	"	"	11.420 "
33	"	"	5.093 "	75	"	"	11.574 "
34	"	"	5.247 "	76	"	"	11.729 "
35	"	"	5.401 "	77	"	"	11.883 "
36	"	"	5.556 "	78	"	"	12.037 "
37	"	"	5.710 "	79	"	"	12.191 "
38	"	"	5.864 "	80	"	"	12.346 "
39	"	"	6.019 "	81	"	"	12.500 "
40	"	"	6.173 "	82	"	"	12.654 "
41	"	"	6.327 "	83	"	"	12.809 "
42	"	"	6.482 "	84	"	"	12.963 "
43	"	"	6.636 "	85	"	"	13.117 "
44	"	"	6.790 "	86	"	"	13.271 "
45	"	"	6.945 "	87	"	"	13.426 "
46	"	"	7.099 "	88	"	"	13.580 "
47	"	"	7.253 "	89	"	"	13.735 "
48	"	"	7.408 "	90	"	"	13.889 "
49	"	"	7.562 "	91	"	"	14.043 "
50	"	"	7.716 "	92	"	"	14.197 "
51	"	"	7.870 "	93	"	"	14.352 "
52	"	"	8.025 "	94	"	"	14.506 "
53	"	"	8.179 "	95	"	"	14.661 "
54	"	"	8.333 "	96	"	"	14.815 "
55	"	"	8.488 "	97	"	"	14.969 "
56	"	"	8.642 "	98	"	"	15.124 "

99	Centigrams	—	15.278	grains.	10	Grams	—	154.323 grains.
1	Gram	"	15.432	"	20	"	"	308.65 "
2	Grams	"	30.864	"	30	"	"	462.97 "
3	"	"	46.297	"	40	"	"	617.29 "
4	"	"	61.729	"	50	"	"	771.62 "
5	"	"	77.162	"	60	"	"	925.94 "
6	"	"	92.594	"	70	"	"	1,080.26 "
7	"	"	108.026	"	80	"	"	1,234.59 "
8	"	"	123.459	"	90	"	"	1,388.91 "
9	"	"	138.891	"	100	"	"	1,543.23 "

CO-EFFICIENTS OF EXPANSION.

By "co-efficient of expansion" is meant the number which expresses the measure of the expansion of a body, when its temperature is raised one degree. The ratio of expansion for gaseous bodies is .003663 of the volume at o.° C. for each degree C., or .002037 for each degree F. This means that the bulk of the gas is increased .003663 on being raised one degree by the Centigrade thermometer, and .002037 on being raised one degree Fahrenheit. In the case of solids and liquids, the ratio of expansion increases as the temperature rises. However, between the freezing point and boiling point of water the increased ratio of expansion is scarcely appreciable, and hence, the mean co-efficient of expansion between o° C. and 100° C. represents closely the expansion for each degree.

The following table gives the co-efficients of linear dilatation for the solids, and the cubical dilatation of the liquids named, referring centigrade thermometric degrees:

Glass	.000000086
Iron	.000000122
Zinc	.000000294
Mercury	.0001543
Water	.000466
Alcohol	.00116
Air	.003665
Hydrogen	.003668

Liquids being always measured in glass, which itself dilates, the expansion observed is only *apparent*, being less than the *true expansion*, and requiring correction for the cubical dilatation of glass. This correction is, however, generally ignored, the difference being in most cases insignificant.

Professor A. B. Lyons, of Detroit, has prepared a set of tables giving the differences in specific weight, and the co-efficients of expansion, apparent and true, for a number of liquids, which tables are here re-produced. The co-efficient of expansion of a dilute solution is, of course, different from the co-efficient of expansion of a concentrated solution of the same substance, and Dr. Lyons' tables, therefore, give the co-efficients of acids of various degrees of strength.

If the observed specific weight be represented by a, the co-efficient of expansion by b, the number of degrees difference by the thermometric scale by c, and the corrected specific weight sought by x, the formulæ for making the required corrections may be stated as follows:

Rule for correcting specific weight observed at a higher temperature to real specific weight at standard temperature:

$$\frac{1 - b \times c}{a} = x$$

Rule for correcting specific weight at a lower temperature to real specific weight at standard temperature:

$$\frac{a}{1 + b \times c} = x$$

The tables here given are taken from *The Pharmacist*, November, 1885, and the values they present are largely deduced from Dr. Lyons's own observations.

WEIGHT OF A BUSHEL.

Various States and Territories of the United States have established by law the weight in pounds, avoirdupois, of a bushel of different commodities. The following table includes all of these legalized local standards:

APPLES, Fresh.—Maine, 44 lbs.; Oregon and Washington, 45 lbs.; Vermont, 46 lbs.; Michigan, Iowa and Missouri, 48 lbs.· New Jersey, 50 lbs.· Wisconsin, 57 lbs.

APPLES, Dried.—Ohio and Michigan, 22 lbs.; Georgia, Kentucky, Illinois, Iowa, Nebraska, Missouri, and Kansas, 24 lbs; New Jersey, West Virginia, and Indiana, 25 lbs.; Virginia, Wisconsin, Minnesota, Oregon, and Washington, 28 lbs.

BARLEY.—Louisiana, 32 lbs.; Arizona and Washington, 45 lbs; Oregon, 46 lbs.; Pennsylvania, Maryland, Georgia, and Kentucky, 47 lbs.; Maine, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Virginia, West Virginia, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Nebraska, Missouri. Kansas, Colorado, Dakota, and Montana, 48 lbs; California, 50 lbs

BEANS.—New Hampshire, Vermont, New Jersey, Virginia, West Virginia, Georgia, Ohio, Indiana, Kentucky, Illinois, Michigan, Wisconsin, Iowa, Nebraska, Missouri, Kansas, Colorado, Dakota, Montana, and Washington, 60 lbs.; New York, 62 lbs.; Maine, 64 lbs.; Arizona, small white beans, 60 lbs.; other beans, 55 lbs.; Connecticut, white beans, 60 lbs.

BEETS.—Wisconsin, Montana, and Washington, 50 lbs.; Maine, Vermont, Connecticut, and Dakota, 60 lbs.

BERRIES (See Currants, Gooseberries and Grapes).—Iowa and Rhode Island, 32 lbs.; Michigan, 40 lbs,

BLACKBERRIES.—See Berries.

BLUE-GRASS SEED.—Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Missouri, Montana, Nebraska, Virginia, and West Virginia, 14 lbs.

BRAN.—Dakota, Illinois, Iowa, Kansas, Kentucky, Missouri, and Nebraska, 20 lbs.

BROOM-CORN SEED.—Dakota and Iowa, 30 lbs.

BUCKWHEAT.—California and Dakota, 40 lbs.; Minnesota, Oregon and Washington, 42 lbs.; Vermont, 46 lbs., Connecticut, Maine, Maryland, Massachusetts, Michigan, New York, and Pennsylvania, 48 lbs.; Indiana, Kansas, New Jersey, Ohio, and Wisconsin, 50 lbs.. Colorado, Illinois, Iowa, Missouri, Montana, Nebraska, Virginia, and West Virginia, 52 lbs.; Kentucky 56 lbs

CASTOR BEANS.—Kansas, 44 lbs.; Kentucky, 45 lbs.; Illinois, Indiana Iowa Michigan, Minnesota, and Nebraska, 46 lbs.

CARROTS.—Maine, Montana, and Vermont, 50 lbs.; Connecticut, 55 lbs.; Rhode Island, 60 lbs.

CHERRIES.—Iowa, 40 lbs.

CHESTNUTS.—Virginia, 57 lbs.

CLOVER SEED.—Montana, 45 lbs; Colorado, Dakota, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, New York, Ohio, Oregon, Vermont, Virginia, Washington, West Virginia, and Wisconsin, 60 lbs.; Pennsylvania, 62 lbs.; New Jersey, 64 lbs.

COAL, Anthracite.—Kentucky, 76 lbs.; Dakota, Illinois, Iowa, Kansas, Nebraska, Virginia, and West Virginia, 80 lbs.

COAL, Bituminous.—Colorado, Michigan, Missouri, Ohio, and West Virginia, 80 lbs.; Indiana, 70 lbs, when mined out of the State, but 80 lbs. when mined in the State.

COAL, Cannel.—Ohio, 70 lbs.

COKE.—Iowa, 38 lbs.; Ohio and Pennsylvania, 40 lbs.

CORN, in the Ear.—Indiana, 68 lbs.; California, Dakota, Illinois, Iowa, Kansas, Kentucky, Michigan, Nebraska, Ohio, and Virginia, 70 lbs.

CORN, Shelled.—California, 52 lbs.; Arizona, 54 lbs.; all other States and Territories, 56 lbs.

CORN, Cracked.—Massachusetts, 50 lbs.

CORN MEAL.—Delaware, sifted meal, 44 lbs, unsifted, 48 lbs.; Illinois, 48 lbs.; Colorado, Connecticut, Indiana, Kansas, Kentucky, Maine, New Hampshire, Rhode Island, and Virginia, 50 lbs.

COTTON SEED.—Georgia, 30 lbs.; Missouri, 33 lbs.

CRANBERRIES.—Michigan, 40 lbs.

CURRANTS.—Iowa, 40 lbs.

DRIED FRUITS.—See Apples, Peaches, and Plums.

FLAXSEED.—Kansas, 54 lbs.; Illinois, New Jersey, and New York, 55 lbs.; Dakota, Iowa, Kentucky, Michigan, Missouri, Nebraska, Ohio, Virginia, West Virginia, and Wisconsin, 56 lbs.

GOOSEBERRIES —Iowa, 40 lbs.

GRAPES.—Iowa, 40 lbs.

GRASS SEED.—See Blue Grass, Clover, Hungarian, Millet, Orchard Grass, and Timothy.

HAIR, for Plaster.—Illinois, Kansas, Kentucky, Nebraska, and Virginia, 8 lbs.; Maine, 11 lbs

HEMPSEED.—Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Missouri, Nebraska, Ohio, and Virginia, 44 lbs.; Montana, 52 lbs.;

HOMINY.—Ohio, 60 lbs.

HUNGARIAN GRASS SEED.—Virginia, 48 lbs.; Kansas, Kentucky, Michigan, Ohio, 50 lbs.; Nebraska, 60 lbs.

INDIAN CORN.—See Corn.

LIME.—Kentucky, 35 lbs.; Michigan (stone lime), 70 lbs.; Colorado, Dakota, Illinois, Iowa, Kansas, Nebraska, 80 lbs.

MAIZE.—See Corn and Hominy.

MALT.—Nebraska, 30 lbs.; Kansas, 32 lbs.; Ohio, 34 lbs.; Illinois and Virginia, 38 lbs.

MANGOLD WURTZEL.—Maine and Rhode Island, 60 lbs.

MEAL, Corn.—See Corn.

MEAL, Rye.—Connecticut, Maine, New Hampshire, and Rhode Island, 50 lbs.

MILLET SEED.—Nebraska, 40 lbs.; Iowa, 45 lbs.; Kansas, Kentucky, Michigan, Ohio, and Virginia, 50 lbs.

OATS.—Maryland, 26 lbs.; Maine, New Hampshire, New Jersey, and Pennsylvania, 30 lbs.; Arizona, California, Colorado, Conneticut, Dakota, Illinois, Kansas, Kentucky, Louisiana, Massachusetts, Michigan, Minnesota,

Missouri, New York, Ohio, Rhode Island, Vermont, Virginia, West Virginia, and Wisconsin, 32 lbs.; Iowa, 33 lbs.; Nebraska, 34 lbs.; Montana, 35 lbs.; Oregon and Washington, 36 lbs.

ONIONS.—Indiana, 48 lbs.; Connecticut, Ohio, Rhode Island, and Washington Territory, 50 lbs.; Dakota, Maine, Massachusetts, and Vermont, 52 lbs.; Michigan, 54 lbs.; Colorado, Illinois, Iowa, Kansas, Kentucky, Missouri, Montana, Nebraska, and Virginia, 57 lbs

ONION SETS.—Nebraska, 25 lbs.; Virginia, 28 lbs.

ORCHARD GRASS SEED.—Michigan and Virginia, 14 lbs.

OSAGE-ORANGE SEED.—Iowa and Nebraska, 32 lbs.; Michigan, 33 lbs.; Vieginia, 34 lbs.

PARSNIPS.—Connecticut, 45 lbs.; Missouri, 50 lbs.; Rhode Island, 60 lbs.

PEACHES.—Virginia, 18 lbs.

PEACHES, Dried.—Michigan, Minnesota, Oregon, Washington, Territory, and Wisconsin, 28 lbs.; Illinois, Indiana, Iowa, Kansas, Missouri, Nebraska, Ohio, and West Virginia, 33 lbs.; Georgia, dried and peeled, 38 lbs.; Kentucky, 39 lbs.; Virginia, peeled and dried peaches, 40 lbs.

PEANUTS.—Virginia, 22 lbs.

PEARS.—Same as Apples.

PEASE.—Connecticut, Dakota, Kentucky, Maine, Michigan, Nebraska, New Hampshire, New York, Ohio, Vermont, and Virginia, 60 lbs.

PEASE, Ground.—Kentucky, 24 lbs.; Georgia, 25 lbs

PLUMS, Dried.—Michigan, 28 lbs.

POTATOES, Irish.—Washington Territory, 50 lbs.; Ohio, 58 lbs.; Colorado, Connecticut, Dakota, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, Oregon, Rhode Island, Vermont, Virginia, West Virginia, Wisconsin, 60 lbs.

POTATOES, Sweet.—Kentucky, 45 lbs.; Dakota, 46 lbs.; Kansas, Nebraska, and Ohio, 50 lbs.; Illinois, 55 lbs.; Michigan and Virginia, 56 lbs.; Rhode Island, 60 lbs.

QUINCES.—Same as Apples.

RAPE-SEED,—Wisconsin, 50 lbs.

RASPBERRIES.—Same as Blackberries.

REDTOP SEEDS.—Virginia, 12 lbs.; Michigan, 14 lbs.

RUTABAGAS.—Wisconsin, 56 lbs.; Connecticut and Maine, 60 lbs.

RYE.—Louisiana, 32 lbs.; California, 54 lbs.; Pennsylvania, 58 lds.; all other States and Territories, 56 lbs.

RYE MEAL.—Connecticut, Maine, New Hampshire, and Rhode Island, 50 lbs.

SALT.—Indiana, Iowa, Kansas, Kentucky, Missouri, Montana, Nebraska, Virginia, 50 lbs.; Michigan, for Michigan salt, 56 lbs.; New York, 56 lbs.; Wisconsin, 60 lbs.; Pennsylvania, for foreign ground salt, 70 lbs.; Massachusetts. 70 lbs.; Colorado and Dakota, 80 lbs. See also

SALT, Coarse.—Illinois, 50 lbs.; Pennsylvania, foreign salt, 80 lbs. See also Salt, and

SALT, Fine.—Illinois and Kentucky, 55 lbs.; Pennsylvania, foreign salt, 62 lbs. See also Salt, and Salt, coarse.

SEED.—See Blue Grass, Broom Corn, Clover, Cotton, Flax, Grass, Hemp, Hungarian Grass, Millet, Orchard Grass, Osage Orange, Rape, Red Top, Sorghum, and Timothy.

SORGHUM SEED.—Iowa and Nebraska, 30 lbs.

STRAWBERRIES.—Same as Blackberries.

SUGAR BEETS.—Connecticut, Maine, and Rhode Island, 60 lbs.

TIMOTHY SEED.—Dakota, 52 lbs.; Montana and New York, 44 lbs.; Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Missouri, Nebraska, Ohio, Vermont, Virginia, and West Virginia, 45 lbs.; Wisconsin, 46 lbs.

TURNIP.—Connecticut and Maine, common English turnips, 50 lbs.; Montana and Washington Territory, 50 lbs.; Illinois, Iowa, Kansas, Nebrask, Virginia, 55 lbs.; Michigan, 58 lbs.; Dakota, Kentucky, Rhode Island, Vermont, 60 lbs.

VEGETABLE (not specified).—Rhode Island and Washington Territory, 50 lbs.

WHEAT.—A bushel of wheat is 60 lbs. in all States: Rhode Island, however, has no law fixing its value.

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